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MATHEMATICS ASSESSMENT
1985

Summary Report

A REPORT TO
THE MINISTRY OF EDUCATION
PROVINCE OF BRITISH COLUMBIA

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THE 1985 BRITISH COLUMBIA MATHEMATICS ASSESSMENT

SUMMARY REPORT

by

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Submitted to the
Student Assessment Branch
Ministry of Education

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TABLE OF CONTENTS

PREFACE.. v

HIGHLIGHTS..................................... 1

1. OVERVIEW..................................... 5

2. THE STUDENTS OF MATHEMATICS.................. 9

3. STUDENTS' ACHIEVEMENT........................ 15

4. THE TEACHERS OF MATHEMATICS.................. 45

5. CONCLUSION AND RECOMMENDATIONS............... 51

APPENDICES

A. Members of Review Panels....................... 56

B. Members of Interpretation Panels............... 57

C. List of Pilot Schools.......................... 58

PREFACE

This is the third Mathematics Assessment to have been conducted in British Columbia; the first two took place in 1977 and 1981. This *Summary Report* contains a description of the major components of the 1985 study, an analysis of the major findings, and a set of recommendations directed toward those whose responsibility it is to ensure the continued improvement of the teaching and learning of mathematics in our schools. This includes not only the teachers of mathematics, but also the Ministry of Education, teacher educators, and educational researchers.

One of the major goals of this Assessment, and of all others conducted by the Ministry of Education through the Learning Assessment Program, has been to provide, to all interested parties, a portrait of the state of mathematics education in our schools. It is the hope of the members of the Contract Team who conducted this study that the information provided through this report, and the *General Report*, will contribute both to an improved understanding of what mathematics is being taught and learned in the schools of the province, and to the development of new programs for our students.

No project of this scope could be completed successfully without the cooperation and participation of the teachers and principals throughout the province. In a particularly trying period for education, when cutbacks and rumours of cutbacks were rampant, their willingness to participate in such a project was commendable, and attests to their high degree of professionalism.

A number of individuals provided valuable assistance with various aspects of this Assessment, and we would like to acknowledge our debt to them. The list includes Lorraine Baron, Catharine Farkas, Bonnie Isles, Sandy Luedtke, Teresa Robitaille, and Jane Smith.

A special word of thanks goes to Art Olson of the Student Assessment Branch of the Ministry of Education, for his help with all aspects of the study, and to our colleagues on the Contract Team. Les Dukowski, Wendy Klassen, Garry Phillips, Todd Rogers, and Alan Taylor are all dedicated educators. Without their expertise and dedication, the project would never have succeeded.

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HIGHLIGHTS OF THE 1985 MATHEMATICS ASSESSMENT

The 1985 Mathematics Assessment focussed on a number of important aspects of the teaching and learning of mathematics in British Columbia. These were:

- the extent to which students in Grades 4, 7, and 10 were achieving the objectives of mathematics education as specified in the Curriculum Guide;
- the current state of students' knowledge of a number of topics such as geometry, problem solving, probability, and statistics, which are likely to play a more prominent role in the revised mathematics curriculum which is currently being developed;
- changes in students' achievement at the Grade 4 level since the 1977 and 1981 Assessments;
- the relationship between certain aspects of students' personal and academic backgrounds and their achievement in mathematics;
- the opinions and attitudes of teachers of mathematics on a variety of matters concerning the teaching and learning of mathematics.

The Mathematics Assessment was carried out in all the schools of the province in May, 1985. Slightly more than 95 000 students enrolled in Grades 4, 7, and 10 completed assessment booklets designed to assess their mastery of seven content domains: Number and Operation, Geometry, Measurement, Algebraic Topics, Probability and Statistics, Computers and Calculators, and Problem Solving. Of these, the Probability and Statistics and Computers and Calculators domains dealt with material which was not part of the curriculum as defined at the present time. They were included in order to obtain information concerning students' familiarity with these topics which are likely to figure prominently in the revised curriculum which is expected to be implemented in the near future.

Results obtained by the students were evaluated by three Interpretation Panels which had been set up for that purpose, one for each participating grade level. The panelists assigned a rating of Strong, Very Satisfactory, Satisfactory, Marginal, or Weak to each result.

Among the major findings of the Assessment were the following:

- The ratings given by the Interpretation Panels to the Grade 4 and Grade 7 results were generally positive, indicating that the panelists were satisfied with the levels of performance demonstrated by the students. Grade 10 results were rated substantially lower than the other two, and the members of the Grade 10 Interpretation Panel expressed concern about students' performance in a number of areas.

- Grade 4 students in 1985 outperformed those in 1977 and 1981 on items which were common to the three projects. The results show a consistent trend toward improved performance at this grade level. No such comparisons were possible at either the Grade 7 or the Grade 10 level.

- The Curriculum Guide stipulates that all students are to follow the same basic mathematics program through Grade 10. In fact, approximately 20% of Grade 10 students are enrolled in courses labelled General Mathematics or Modified Mathematics.

- Results obtained by Grade 10 students enrolled in Modified or General Mathematics classes were much lower than those obtained by students following the regular Mathematics 10 course, even in an area such as arithmetic skills which is frequently the focus of most General Mathematics courses. The Ministry of Education should investigate the nature of the mathematics courses being offered in Grades 8 through 10, with a view to standardizing the content of those courses and the streaming practices being employed.

- In spite of the very large amounts of time devoted to the development of computational skills, significant numbers of students have difficulty using such standard algorithms as the one for long division with whole numbers. Consideration should be given to the possibility of permitting students to use calculators for such tasks, thereby providing additional time to be devoted to the development of an understanding of the algorithms and when to use them.

- Virtually all teachers own calculators and use them extensively for non-instructional work inside and outside of school. A large proportion of teachers, particularly at the elementary school level, either do not permit their students to use calculators in mathematics classes, or apply restrictions to their use.

- Most students own calculators and use them outside of school. Almost all elementary students reported that they were not permitted to use calculators on tests, and most said they were not permitted to use them at all in their mathematics classes.

- Almost all schools have one or more computers, and about 30% of teachers and students report that they have computers at home. Teachers believe it will be essential for students to know more about computers, and students report that they would like to learn more about them.

- Students' performance in geometry was relatively weak, and information obtained from both teachers and students makes it clear that geometry is not accorded a high priority in the mathematics curriculum.

- Results on items dealing with fractions and decimals were rather disappointing at all three grade levels. Many of the concepts involved in a treatment of the rational numbers are highly abstract, and students, particularly the younger ones, might benefit from more preliminary work with concrete or pictorial representations of these entities rather than concentrating too soon on the manipulation of the symbols.

- Students at all three grade levels had difficulty on items dealing with estimation. More time needs to be devoted to this important topic.

- Differences in achievement levels between boys and girls were small; virtually all such differences at the domain level were less than five percentage points.

- Boys and girls appear to have fairly non-stereotyped views of mathematics with respect to gender. Thus the majority of students, particularly at the upper grade levels, disagree with statements such as, "Men make better scientists and engineers than women." There is a tendency for the sexes to respond in a chauvinistic way to such statements, however. Thus, more girls than boys think "A woman needs a career just as much as a man does," and more boys than girls think that "Men make better scientists and engineers than women do."

- Although there has been a modest degree of improvement in usage of the metric system since 1981, students are still more likely to use imperial units than metric ones in everyday measurement situations.

- Almost all students, regardless of grade level, have regular homework assignments in mathematics. Most of them report spending less than half an hour on such assignments.

- Teachers are of the opinion that more attention should be given to the teaching of problem solving in mathematics. They are also of the opinion that the resources available to them at the present time for this task are inadequate.

- Significant numbers of teachers at all three grade levels report that they have had no post-secondary level training in mathematics or in the teaching of mathematics. In fact the proportions of such teachers have increased since 1981.

1. OVERVIEW

The third British Columbia Mathematics Assessment was conducted during the 1984-85 school year. In the latter part of May, students in Grades 4, 7, and 10 throughout the province, plus a probability sample of Grade 8 students, completed test booklets which included a set of background information items, attitude inventories, and achievement items. At the same time, teachers of mathematics at those same grade levels completed questionnaires developed for use in the project. The Assessment was conducted under the auspices of the Student Assessment Branch of the Ministry of Education by a Contract Team composed of three university professors and three teachers of mathematics. The Educational Research Institute of British Columbia (ERIBC) served as the technical agency for the study.

The first two British Columbia Mathematics Assessments (Robitaille & Sherrill, 1977; Robitaille, 1981) were carried out in 1976-77 and 1980-81. Both of those projects involved students from Grades 4, 8, and 12. In 1981, a sample of Grade 10 students was included as well. The decision to include Grade 10 and exclude Grade 12 from the third Assessment was based on the re-introduction of provincial secondary school leaving examinations two years ago. The decision to change from testing at Grade 8 to Grade 7 had been contemplated for several years, and was first done in the 1984 Reading Assessment. Grade 7 is the last year of elementary schooling in B.C. and represents a major breakpoint in the provincial educational system. For that reason it seemed appropriate to include Grade 7 in an assessment program such as this.

Organization of the Assessment

Several groups of people participated in the design and execution of the 1985 Mathematics Assessment. In addition to approximately 95 000 students and their teachers, these included the staff of the Student Assessment Branch of the Ministry of Education, the members of the Contract Team, personnel from ERIBC, as well as the members of the Advisory Committee, the Technical Sub-Committee, the Review Panels, the Interpretation Panels, and the teachers and students from those schools which assisted in pilot-testing the instruments.

The Contract Team had primary responsibility for designing the Assessment, developing the instruments to be utilized in the project, and writing the final reports. The team included two members of the Faculty of Education at the

University of British Columbia, one member of the Faculty of Education at Simon Fraser University, two elementary school teachers from the New Westminster and Richmond School Districts, and a secondary school vice-principal from Langley.

As the technical agency for the Assessment, ERIBC was responsible for printing, distributing, and collecting the Assessment booklets and questionnaires; for selecting the Grade 8 sample; for scoring the responses and analyzing the data; and for providing consultative services to the Student Assessment Branch and the Contract Team on matters related to the technical, statistical, and psychometric aspects of the study.

The Technical Sub-Committee consisted of representatives from the Student Assessment Branch, the Contract Team, and ERIBC. The function of this committee was to provide a forum for the discussion of matters of a technical or statistical nature related to the assessment.

The Advisory Committee provided guidance and advice to the Contract Team and the Student Assessment Branch on the development of the instruments and on the interpretation of the findings. They also chaired the meetings of the Review Panels and Interpretation Panels. The members of the Advisory Committee were selected from across the province by the Student Assessment Branch to reflect a cross-section of opinion on matters related to the teaching and learning of mathematics. The committee included among its members three teachers and a principal, as well as personnel from the Ministry of Education and the Chairman of the Contract Team.

The Review Panels and Interpretation Panels were made up of educators and informed members of the public selected from across the province. Their task was to discuss the objectives of this Assessment and to comment on the test items, attitude scales, and questionnaires developed for use in the study. The Interpretation Panels met after the Assessment data had been analyzed to examine the results and to comment on the students' performance.

Scope of the Assessment

The Learning Assessment Program is based on the premise that systematic collection and dissemination of comprehensive, reliable data are essential components of the effective management of education in this province. Decisions about new directions or new emphases in educational matters should be based upon a clear understanding of what students are learning and how they are being taught.

The objectives of province-wide Assessments are as follows:

- to inform professionals and the public of some of the strengths and weaknesses of the public school system;
- to assist the Ministry, school districts, and schools in decisions related to the development, review, modification, revision, and implementation of curricula and supporting instructional resource materials;
- to assist the Ministry in decisions concerning allocation of resources;
- to identify areas of need and provide directions for change in both pre-service and in-service teacher education and professional development;
- to provide directions for educational research;
- to monitor student learning over time; and
- to provide the province, school districts, and schools with information which can be used to maintain strengths and overcome identified weaknesses.

Within the framework of these general guidelines, the 1985 Mathematics Assessment was designed to address the following questions:

- To what extent are students in Grades 4, 7, and 10 achieving the objectives of mathematics education as specified in the current curriculum guide?
- What is the status of students' knowledge of certain topics, such as geometry, problem solving, and statistics, which are likely to play a more important role in the revised mathematics curriculum which is under development at the present time?
- To what extent have levels of achievement changed from those reported in 1977 and 1981, and how do achievement levels in British Columbia compare to those in other jurisdictions?
- How are achievement levels related to certain aspects of students' backgrounds, their attitudes and opinions, and those of their teachers?
- What are teachers' opinions and attitudes about a number of important issues in mathematics education?

Although a conscientious effort was made to obtain reliable data to address each of these questions, it was not entirely possible to do so. In the case of changes in patterns of achievement since the 1977 and 1981 Assessments, for example, serious doubts about the representativeness of the Grade 10 sample used in 1981 and the Grade 8 sample used in 1985 were raised, and a decision was made to not include any discussion of the change data at these two grade levels. A more detailed discussion of the sampling problem is contained in Chapter 2 of the *General Report*.

A difficulty also arose in connection with two items at each grade level, which sought information about the highest level of education attained by parents. Although these items had been used with apparent success in other projects and in other jurisdictions to obtain information about socio-economic status, they did not appear to work properly in this Assessment. The results, particularly at the Grade 4 level, conflicted with data available from other sources. For that reason, no use has been made of that data.

To summarize, the 1985 Mathematics Assessment, like its two predecessors, was designed to produce a portrait of the state of mathematics education in the schools of the province. The major areas addressed in this report concern students' achievement levels, their attitudes and opinions about a number of topics of contemporary interest in the field, and the opinions and attitudes of the teachers of mathematics.

References

Robitaille, D.F., & Sherrill, J.M. (1977). *The B.C. Mathematics Assessment: Test Results.* Victoria, B.C.: Ministry of Education.

Robitaille, D.F. (Ed.). (1981). *The 1981 B.C. Mathematics Assessment: General Report.* Victoria, B.C.: Ministry of Education.

2. THE STUDENTS OF MATHEMATICS

The Assessment was directed at all students in Grades 4, 7, and 10. Based on enrollment data as of February 1985, participation rates were 94% for Grade 4, 94% for Grade 7, and 75% for Grade 10. The non-participation rates for Grades 4 and 7 are within the range of normal absentee rates. The higher rate of non-participation at the Grade 10 level may indicate that, at least in some schools, the Assessment instruments were not administered as directed to all students enrolled in Grade 10.

About 90% of Grades 4 and 7 students had English as their first language, and about 6% spoke a language other than English at home. In Grade 10, 84% had English as their first language, and 8% spoke a language other than English at home. Eight percent of Grade 7 students were registered in a French Immersion Programme or in the *Programme Cadre de Français*.

Homework assignments in mathematics were given in almost all classes at the three grade levels, and Grade 10 students spent somewhat more time doing homework than those in Grade 4 or Grade 7. About 50% of students in Grades 7 and 10, and 70% of those in Grade 4 spent less than 30 minutes per day on mathematics homework.

When asked to select the most important reason for studying mathematics, about 50% of students in Grades 7 and 10 chose, "to learn how to use mathematics to solve problems in the real world." Few indicated a desire to learn about the nature of mathematics. These results are consistent with those expressed by Grade 8 and 12 students in the Second International Mathematics Study in British Columbia. Students appear to value mathematics for its utility rather than as a study in itself.

In the past, it has been difficult to ascertain the number of students studying mathematics under a semester system at the secondary level. Data obtained from the students, corroborated by teachers' reports, indicate that approximately 16% of Grade 10 students were enrolled in semestered mathematics courses during the second semester of the 1984-85 school year.

The present Curriculum Guide specifies just one Mathematics course for Grade 10 students. Nevertheless, only 73% of Grade 10 students were enrolled in a mathematics course designed to prepare them to take Algebra 11. Of the remaining students, 19% were enrolled in courses which are commonly referred to as General Mathematics 10 or Modified Mathematics

10. Little is known about the intent and content of such courses, and it is hoped that the revised mathematics curriculum will help to standardize the curriculum for all students.

Metric Usage

Students were asked to respond to four items to determine the extent to which they used metric units when responding to statements about mass, temperature, distance, and capacity. Each item took the form of a question followed by two correct answers, one in SI metric units and the other in imperial units. Students were directed to choose the response which came to mind first. The items and response rates are shown in Table 2-1.

Table 2-1
Responses to Metric Usage Items
(Percent Choosing Metric Response)

	1981			1985		
Unit	Gr 4	Gr 8	Gr 12	Gr 4	Gr 7	Gr 10
Mass	40	27	17	47	38	28
Temperature	62	39	40	76	61	58
Distance	37	31	22	43	39	32
Capacity	41	24	20	51	40	37

Most students favoured imperial units of measure of mass, distance, and capacity, whereas a majority selected metric units of temperature. Compared to 1981, students at all grade levels showed increased acceptance of the metric system, but the rate of change has been slow. Students in the higher grades demonstrated a lesser degree of metric usage than Grade 4 students.

The overall results are disappointing when it is considered that the schools have been completely metric for more than ten years. Most students still do not "think metric;" and, in view of the federal government's permitting both systems to be used, it is likely that students will continue to use a mixture of both.

Mathematics in School

An attitude scale entitled *Mathematics in School* was administered as part of the Assessment. At each level the scale consisted of a list of 10 important topics from the mathematics curriculum at that grade level. Students were asked to indicate how important they thought each topic was, how easy the topic was for them, and how much they liked the topic.

Students in all three grades gave solving word problems a rating of moderate importance. Grade 4 students also rated it about average in terms of difficulty and enjoyment. Grade 7 students, on the other hand, reported it to be the most difficult, the least liked, and one of the least important topics. Grade 10 students also rated it the most difficult and one of two least liked topics. As grade level increased, students tended to rate the topic less important, more difficult, and less enjoyable. These relatively negative attitudes toward problem solving may make it difficult to implement a curriculum which assigns problem solving a more prominent role.

Of all the topics listed, students rated those dealing with number and operations on number most important. Geometric topics were rated much less important, although Grade 4 students felt they were easy and enjoyable. Grade 10 students ranked working with congruent and similar figures last on all three dimensions. The results confirm those reported in earlier Assessments to the effect that students, as well as teachers, attach little priority to geometry. From the results of previous Assessments and other studies, it would seem that students and teachers have similar, and consistent, views of the relative importance of various mathematical topics. If geometric topics are to be emphasized in the new curriculum, much work needs to be done to make students and teachers aware of the importance of geometry within mathematics and for its applications in everyday life.

Calculators and Computers

Students completed twenty items designed to gain information on their use of calculators and computers. Results relating to students' ownership and use of calculators are shown in Table 2-2.

Calculator ownership increased with grade level, as did the use of calculators both inside and outside school. Ownership and use, both in and out of school, have increased since the 1977 and 1981 Assessments. However, in spite of the fact that most students own and use calculators, most elementary students reported that they were not allowed to use calculators in their mathematics class, and almost none were permitted to use them on mathematics tests. The National

Council of Teachers of Mathematics has endorsed the use of the calculator as an instructional tool, and many good references on how to use the calculator to teach mathematics are available.

Table 2-2
Calculator Ownership and Use
(Percent of Students)

	Grade 4	Grade 7	Grade 10
Own a calculator	53	71	86
Never use one outside school	51	32	18
Never use one inside school	91	72	25
Not permitted in math class	79	62	24
Not permitted on math tests	97	92	41

About 30% of students said they had computers at home, and a large majority at each grade level had some experience with computers. About 80% of all students said they would like to learn more about computers, and about 70% felt that schools should teach all students how to use computers. About 80% thought that computers could be used to teach mathematics and other subjects in school. Given this positive outlook, it would appear that more work with the computer, as an instrument in itself and as an instructional tool, would be welcomed by the students.

Gender Stereotyping

The *Gender and Mathematics* scale was included in the Assessment to ascertain whether students perceived that males and females differed in their need to study mathematics and in their mathematical ability. Previous studies have shown gender differences in performance, and the question has been raised about the extent to which such differences may be attributable to extrinsic factors, such as the prevailing societal attitudes. It is well known, for example, that fewer girls enroll in mathematics and science courses in senior high school, but not why. Is it the case that girls are less able, or is it a function of pressures exerted on them by their peers and families to enroll in other subjects and pursue non-scientific careers?

Five of the 15 items in the scale were intended to compare students' attitudes about the abilities of males and females in mathematics. Grade 4 students indicated some evidence of sexual stereotyping. For example, 33% agreed that men make better scientists and engineers than women, whereas only about 14% of students in Grades 7 and 10 agreed. In Grades 7 and 10, where students are starting to think about what they might do in adult life, about 85% of students agreed that a woman needs a career just as much as a man. At the Grade 10 level, a higher percentage of boys than girls felt that men make better engineers than women and that boys need to learn more mathematics than girls. A greater percentage of girls than boys thought that women need careers just as much as men. Thus, although attitudes are generally positive, there is some evidence of gender-related differences.

Results on the remaining items indicated that differences which students perceived in the extent to which their fathers and mothers enjoyed mathematics, could help their children with mathematics homework, saw mathematics as important, and wanted students to do well in mathematics, were relatively small. For example, about 90% of students indicated that each parent thought learning mathematics was important and wanted the student to do well. Students in higher grades perceived their parents as less interested and less able to help them with mathematics than those at lower grades. Only a minority of students believed that their parents enjoyed mathematics.

3. STUDENTS' ACHIEVEMENT

Students' achievement in mathematics was assessed at three grade levels--Grades 4, 7, and 10--over seven content *domains*, each of which was subdivided into several *objectives*. The Interpretation Panels considered the results obtained by the students on each item, objective, and domain, and assigned summary ratings to those levels of performance. The rating categories which they used were:

Strong	ST
Very Satisfactory	VS
Satisfactory	S
Marginal	M
Weak	W

A summary of the ratings given by the three Interpretation Panels is presented in Table 3-1.

Table 3-1
Summary of Interpretation Panel Ratings

Domain	Rating		
	Grade 4	Grade 7	Grade 10
Number & Operation	S	S	M
Geometry	S	M to S	M
Measurement	M to S	M	S
Algebraic Topics	S to VS	S	M
Probability & Statistics *	-	-	-
Computers & Calculators *	-	-	-
Problem Solving	M	S	S

* Non-curricular domain.

These ratings are difficult to summarize or to compare since they were made by different groups of people at each grade level. Similarly, it is difficult to make comparisons with ratings from previous Assessments, not only because the members of the Interpretation Panels were different, but also because the items on which the ratings were based and the grade levels at which the Assessments were conducted were different.[1]

The Grade 4 and 7 results were, for the most part, Satisfactory; the Grade 10 results, less so. In comparison with the 1981 ratings, and taking into account the changed grade levels, this year's results are very much the same as those from 1981. There is, perhaps, a very slight shift toward a more positive evaluation, particularly at the Grade 4 level.

The first four of the seven domains encompass the majority of topics included in the currently authorized mathematics curriculum in British Columbia. Topics from the other three domains may be referred to at certain grade levels, but they are not major components of the curriculum.

The *Probability and Statistics* and *Computers and Calculators* domains were included in the Assessment because it is widely believed that these topics should be part of the new curriculum, and that we should have some preliminary information about students' understanding of a number of basic concepts in these areas. Because these domains concerned content which was not part of the standard curriculum, the Interpretation Panels decided that it would be inappropriate to rate students' performance in these areas on the same scale as other domains. For that reason, no performance ratings are shown in the Table 3-1 for those domains.

Problem Solving was included as a separate domain for similar reasons. Learning to solve problems in mathematics is an important part of the current curriculum, but consists mainly of straightforward applications of the skills and concepts being learned. In the *Problem Solving* domain, however, students' abilities to solve non-routine problems, that is, problems which required them to use particular strategies, were assessed. The inclusion of this type of problem solving as an integral part of the mathematics curriculum at all grade levels has been urged by a number of influential groups throughout North America, and this topic is also likely to be featured in the new curriculum for the schools of this province.

To provide adequate coverage of the content of the seven domains at each grade level, 150 achievement items were used. These were distributed evenly among three booklets at each grade level, 50 to a booklet. All of the items were expressed in multiple-choice format with five response options. Four of these were possible answers to the item; the fifth was "I don't know." The number of items included in each domain varied from grade to grade depending upon the relative importance of each particular domain at that level.

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[1] The 1977 and 1981 Mathematics Assessments were conducted in Grades 4, 8, and 12. In 1981 a sample of Grade 10 classes was included, but no interpretation of those results was made.

An important innovation in this Mathematics Assessment was the inclusion of two booklets at each grade level which consisted mainly of open-ended items. Items in these booklets were selected to assess the processes employed by students in performing certain mathematical tasks in a manner that is not possible with multiple-choice items. These so-called *Q*-forms were included in the class sets of booklets distributed to all schools on a 1:25 ratio, in order to provide a 4% provincial sample of students at each grade level.

An analysis of the *Q*-form data was made in order to assess the representativeness of the sample of students who were administered those booklets. Results revealed that, at each grade level, the *Q*-form students outperformed those who took the regular booklets by a significant margin on three multiple-choice items which had been included in both types of booklets for purposes of this comparison. This implies that the *Q*-form sample was not randomly selected, and suggests that the instructions for distributing the Assessment booklets were probably not followed in some schools.

Grade 4 Results

The 150 items included in the three regular Assessment booklets at the Grade 4 level were divided among the various domains and objectives as shown in Table 3-2. Also included in the table are the mean percent correct for each domain and objective, together with the ratings given by the Interpretation Panels.

Number and Operation

This domain is by far the most important in the current curriculum at this level; hence, the relatively large proportion of items assigned to it. Of the 150 items in the Grade 4 pool, 45 were in the Number and Operation domain: 30% of the total. Included in this domain were concepts of place value and operations with whole numbers, as well as elementary concepts of fractions and decimals and the increasingly important topic of estimation.

The Interpretation Panel was generally satisfied with students' performance on the items in this domain, and this is a positive result given the importance of these topics. While performance levels varied from item to item, there were several very gratifying results. For example, on Item S/3[2], which dealt with the topic of place value, almost every student in the province chose the correct response.

Table 3-2
Grade 4: Summary Statistics

Domain/Objective	Number of Items	Provincial Mean (%)	Panel Rating
Number and Operation	**45**	**66**	**S**
No. Concepts and Computation	24	72	S to VS
Estimation	12	65	S
Fractions and Decimals	9	52	M
Geometry	**24**	**63**	**S**
Geometric Figures	12	68	S to VS
Geometric Relationships	12	58	S
Measurement	**27**	**62**	**M to S**
Metric Units	12	60	M
Perimeter, Area, and Volume	9	59	S
Time and Temperature	6	68	S
Algebraic Topics	**18**	**66**	**S to VS**
Expressions, Equations & Inequalities	9	63	S
Graphs	9	69	VS
Probability *	**12**	**55**	**-**
Computers & Calculators *	**12**	**53**	-
Computer Literacy	9	50	-
Calculator Use	3	63	-
Problem Solving	**12**	**47**	**M**

* Non-curricular domain.

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[2] This label refers to Item 3 in Booklet S.

S/3 300 + 40 + 5 is the same as

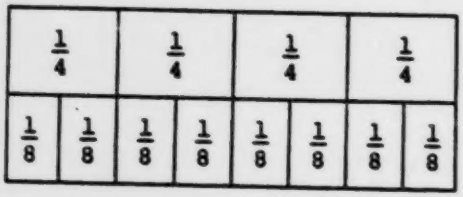
		% of students
A	345	96 *[3]
B	354	2
C	435	1
D	543	1
E	I don't know	1

Estimation is a topic that is gaining increased prominence in mathematics curricula, and it is also an important skill that has many applications in everyday life. For example, students need to be able to estimate the amount of time needed for activities, the amount of money needed to make purchases, and the distance between objects. In mathematics classes, students need to estimate in order to verify the reasonableness of their answers, and this is true even when calculators are used; perhaps especially then.

The Interpretation Panel rated students' performance on this objective Satisfactory. Of the 12 item-results, six were rated Satisfactory; three, Very Satisfactory; and three, Marginal. The members of the Interpretation Panel recommended that teachers give increased emphasis to estimation wherever possible.

Results on items dealing with fractions and decimals were not as good as those for the other two objectives in this domain, and the overall performance was rated Marginal. Students appeared to find even seemingly easy items rather difficult, and Item R/18 is illustrative of this.

R/18 How many eighths are equal to 3/4?



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[3] The asterisk indicates the correct response. The sum of the percents may not equal 100, because of rounding and rates of omission.

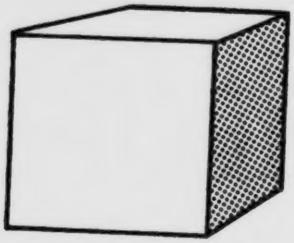
		% of students
A	2	17
B	4	14
C	6	33 *
D	8	11
E	I don't know	24

Even though the item was accompanied by a diagram, which should have made it somewhat easier, only one-third of students chose the correct response. Almost one-fourth of them chose "I don't know." It may be, as was suggested in the reports of previous Assessments, that these concepts are too abstract for children at this age level, and that much more work with manipulative materials is needed in order to build a firm foundation.

Geometry

In the primary grades the focus in the teaching of geometry should be based on a multitude of experiences with concrete representations of geometric objects. The items in the Assessment booklets could not assess such experiences directly, and had to be based on pictorial representations of such objects. For example, in order to respond correctly to Item R/5, students had to be able to visualize a three-dimensional cube given a two-dimensional representation.

R/5 One face is shaded on this cube. How many faces does the cube have?



		% of students
A	3	17
B	6	76 *
C	8	3
D	12	1
E	I don't know	2

Students performed well on this item and on almost all the others related to the Geometric Figures objective. Eleven of the 12 item-results were judged Satisfactory or better, and one was rated Marginal. Performance on the items in the Geometric Relationships objective was equally good.

Measurement

In Section 2 of this report, reference was made to the fact that many students do not use metric units in measurement situations which they encounter in everyday life. In fact it may be the case that the only place in which many students encounter the metric system is in mathematics class, or some other school-based situation. This might explain the relatively poor performance exhibited on the Metric Units objective where five of the 11 item-results were rated Marginal or Weak.

The members of the Interpretation Panel were particularly concerned about the relatively large numbers of students who were unable to do simple conversions between units: for example, to tell the number of centimetres in a metre. Although performance on that particular item increased from 67% correct in 1981 to 76% in 1985, the Interpretation Panel was of the opinion that it should have been considerably higher.

Students demonstrated a lack of familiarity with the term *perimeter*. In Item R/11 they were given a diagram of a rectangle, with the dimensions marked on the diagram, and asked to find "the DISTANCE ALL THE WAY AROUND this rectangle." Sixty-seven percent chose the correct response. Item S/18 was identical except that it asked for the "PERIMETER of this rectangle." Surprisingly, only 45% chose the correct response, a drop of over 20 percentage points.

Performance on the Time and Temperature objective was rated Satisfactory. Students demonstrated Satisfactory or better levels of mastery of tasks such as reading a thermometer, telling time and converting a number of days into weeks. They had more difficulty computing elapsed time and estimating temperature.

Algebraic Topics

This domain included items dealing with a number of topics of fundamental importance to mathematics. Some of these notions are rather abstract, and many children had difficulty with items which dealt with the use of variables in equations, and with the solution of simple equations. In general, performance levels on the items in this domain were lower than those in the other domains discussed thus far, but they were deemed to be Satisfactory by the Interpretation Panel since the underlying ideas were so difficult.

A case in point concerns the notion of a missing addend. In Item T/21 students were asked to find the missing term in an equation, and only 45% were able to provide the correct response. Previous research has shown this type of equation to be the most difficult for students at this level to solve, involving as it does the concept of an inverse operation. The Panel rated students' performance on this item Marginal.

T/21 To find the missing number in
346 + _____ = 931 you should

		% of students
A	subtract 346 from 931	45*
B	add 346 to 931	11
C	subtract 931 from 346	22
D	add 931 to 346	5
E	I don't know	17

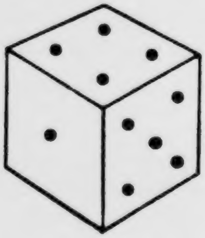
Results on the graphing objective were rated Very Satisfactory, somewhat higher than on the other Algebraic Topics objective: Expression, Equations, and Inequalities. Students see a lot of graphs in the various school subjects in the primary grades, and their performance on these items demonstrates that they know how to read and interpret graphs of several different kinds.

Probability

In today's world a basic understanding of the mathematical notion of uncertainty, and of a number of fundamental ideas in probability, is a necessary part of a general education. In weather forecasts, the likelihood of precipitation is given as a percent chance; the results of political polls are published along with a statement of confidence intervals and likelihood of error. Students need to become familiar with such concepts in order to improve their understanding of the world in which they live.

Since the topics included in this domain are not part of the current curriculum, the Interpretation Panel was reluctant to criticize the results. On the whole, however, results showed that students had some familiarity with the basic concept of an event whose outcomes could not be predicted with certainty. For example, on Item R/15, 80% of Grade 4 students selected the correct response, showing that they had some sense of the possible outcomes of a random event: in this case, rolling a die.

R/15 If you tossed a die, what number would show up?



		% of students
A	1, 2, or 3	3
B	6	3
C	an even number	7
D	any number from 1 to 6	80 *
E	I don't know	7

Computers and Calculators

Results show that although many students own their own calculators or computers, they do not get to use them in school. Most teachers at this level feel it is inappropriate for students to use calculators in school, and given the structure of the elementary school mathematics curriculum this is not an unreasonable position.

On the whole, the Interpretation Panel was satisfied with the extent of students' knowledge about computers and calculators as demonstrated on the items in this domain. Lowest levels of performance were recorded on items dealing with specifics of calculator use or elementary programming concepts, such as the use of an asterisk, "*", to denote the operation of multiplication. These results indicate that students at this level already have some basic knowledge about these devices, and it is likely that they would profit from a more systematic exposure to them in school.

Problem Solving

As indicated earlier, problem solving is an integral part of the mathematics curriculum at all grade levels and in every content domain. The items in the Problem Solving domain were intended to focus on students' ability to work with what are generally called non-routine problems: that is, problems whose solution typically depends upon the application of a strategy other than a straightforward application of an algorithm. The particular items used at the Grade 4 level were intended to assess students' ability to use strategies such as make a list, guess and check, look for patterns, and identify cases of insufficient or extraneous information. An example of the type of item included in this domain is shown below in Item S/40.

S/40 Mrs. Wildish bought some flower bulbs to plant. One half of them were tulip bulbs. What else do you need to know to find out how many were tulip bulbs?

		% of students
A	How big tulip bulbs are	9
B	What other kinds of flowers Mrs. Wildish has	7
C	How many flower bulbs Mrs. Wildish bought	47 *
D	What other types of bulbs Mrs. Wildish bought	17
E	I don't know	15

The Interpretation Panel rated students' performance on the 12 items in this domain Marginal. In fact, seven of the 12 individual item results were rated Marginal, including the result on Item S/40. This indicates that the Panel felt that students should have performed better on these items, even though it might be argued that teaching students to apply these problem-solving strategies is not an explicit part of the current curriculum. The members of the Interpretation Panel suggested that teachers pay more attention to these important skills, and that problem solving be considered an important component of the mathematics curriculum at all grade levels.

Changes in Achievement: 1977-1981-1985

Grade 4 was the only level at which it was possible to document changes in achievement patterns in this third

Mathematics Assessment. Briefly, this analysis shows that the 1985 results are somewhat higher than either the 1977 or 1981 results, and that the trend toward improved scores is consistent. The 1985 results are higher than the 1981 results, and these are higher than the 1977 results on both domains of change items: Number and Operation, and Measurement.

In all, the 1985 Assessment included 22 items which had been used in both the 1977 and 1981 projects. A much larger number of items, 70, appeared in the 1981 and 1985 item pools. When this extended set of items is used, the trends mentioned above are emphasized. Performance levels on four of the five change domains improved by from 1 to 5 percentage points between 1981 and 1985. On the fifth, Geometry, there was no change.

The results of this analysis of change, particularly between 1981 and 1985, where it is based on such a large number of items, are very positive. Students' achievement is improving, not dramatically, but consistently, in all major areas of the curriculum except geometry where no change was found. This latter result is not particularly surprising, given the lack of importance usually assigned to geometry, but it should be taken as a signal for the need to examine carefully what is being done in this important branch of mathematics.

Q-form Results

On the *Q1*-form students were asked to create story problems for each of a number of numerical expressions corresponding to the four fundamental operations with whole numbers which they were given: for example, 28 + 84 and 84 X 28. They performed very well on these items, thereby demonstrating a good understanding of the meanings of these operations. In fact, they did better on these items than they did on a second set where they were given word problems and asked to select the numerical expression which could be used to find the correct answer.

The other *Q*-form booklet consisted mainly of items assessing students' degree of mastery of computational techniques and problem solving. Students did well on the computational items involving whole numbers, but they had difficulty dividing $27.00 by 6. Results on the problem-solving items were encouraging as well, although some of these items proved to be difficult. For example, on Item 18,

> Jerry has a total of 24 golf balls and tennis balls.
> If he has 4 more tennis balls than golf balls,
> how many of each does Jerry have?

about 50% of students gave incorrect and unreasonable answers such as 28: the sum of 4 and 24.

Grade 7 Results

The 150 items included in the three regular Assessment booklets at the Grade 7 level were partitioned among the various domains and objectives as shown in Table 3-3. The table also includes the mean percent correct and the ratings assigned by the Grade 7 Interpretation Panel.

Table 3-3
Grade 7: Summary Statistics

Domain/Objective	Number of Items	Provincial Mean (%)	Panel Rating
Number and Operation	**42**	**63**	**S**
Number Concepts	15	70	S
Fractions and Decimals	18	58	M
Ratio, Proportion & Percent	9	62	S
Geometry	**36**	**53**	**M to S**
Geometric Figures	18	57	S
Geometric Relationships	18	50	M
Measurement	**15**	**54**	**M**
Metric Units	9	60	M
Perimeter, Area & Volume	6	44	M
Algebraic Topics	**24**	**52**	**S**
Expressions, Equations & Inequalities	18	44	M
Graphs	6	76	VS
Probability and Statistics *	**12**	**43**	**-**
Probability	6	44	-
Statistics	6	43	-
Computers & Calculators *	**12**	**39**	**-**
Computer Literacy	6	40	-
Calculator Use	6	38	-
Problem Solving	**9**	**60**	**S**

* Non-curricular domain.

Number and Operation

As with Grade 4, the Number and Operation domain for Grade 7 contained more items than any other domain, reflecting its pre-eminent role in the current mathematics curriculum at the elementary school level. By the end of Grade 7, students are expected to be able to perform the four basic operations of addition, subtraction, multiplication, and division with whole numbers, common fractions, and decimals. They are also expected to be competent with basic ideas in the areas of ratio, proportion, and percent, and to be able to apply this knowledge to the solution of problems.

The Number Concepts objective included 15 items, and the Interpretation Panel rated students' performance on this objective Satisfactory. Students appeared to have a fair degree of difficulty with long division involving 2-digit divisors, as illustrated by Item R/40.

R/40 Divide: $45 \overline{)\ 1232}$

		% of students
A	25 remainder 7	9
B	27 remainder 17	67 *
C	29 remainder 27	9
D	209 remainder 17	5
E	I don't know	8

The Interpretation Panel gave a Marginal rating to this result, and it is indeed a cause for concern. Formal instruction on the use of the long division algorithm begins in Grade 4, or earlier; and yet, after four years of instruction, one-third of students are unable to find the correct answer to a fairly simple division exercise. It seems appropriate to question whether too much time is being devoted to the development of such computational skills, which can be performed much more accurately and quickly on calculators, when so many students are still unable to apply them correctly after so much instruction and practice.

Results on items in the Fractions and Decimals objective revealed similar weaknesses in computational skills with fractions and decimals, and the Interpretation Panel gave an overall rating of Marginal to students' performance on this set of items. They were also concerned about performance on an estimation item, Item S/27, in which a substantial proportion of students showed little or no understanding of the relationship between the size of the addends given in the exercise and their sum.

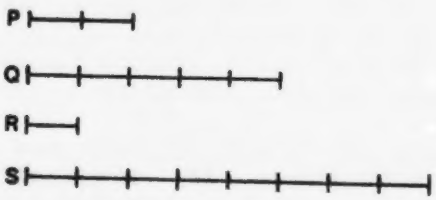
S/27 ESTIMATE the sum: 347.0 + 738.0 + 1.327

		% of students
A	1 000	35 *
B	2 000	19
C	10 000	17
D	100 000	21
E	I don't know	7

In general, students performed more poorly on items involving fractions than on those involving decimals, in spite of the fact that work with fractions is given more emphasis in the current curriculum than the corresponding work with decimals. Perhaps more attention should be paid to work with decimals earlier, and the corresponding work with common fractions should be delayed until the work with decimals has been mastered. A number of other jurisdictions have inaugurated such an approach within the last several years.

Performance on the Ratio, Proportion, and Percent items was judged to be Satisfactory. Students performed well on items dealing with topics such as scale drawing, discount, simple proportions, and finding a percent of a number. They performed less well on an item in which they were required to express a fraction as a percent, and another, shown below, in which they were asked to identify two line segments in a given ratio.

R/8 Which pair of line segments shown below have lengths which are in the ratio of 1 to 4?



		% of students
A	P and Q	21
B	R and S	10
C	P and S	36 *
D	R and T	3
E	I don't know	30

The concept of ratio underlies a great number of topics in mathematics, and the development of proportional reasoning should be an important objective of the elementary mathematics curriculum. The fact that 30% of Grade 7 students chose the "I don't know" option for this item is a cause for some concern, since it indicates a lack of familiarity with the most basic notions of ratio and proportion.

Geometry

Much of the geometric content of the elementary school geometry curriculum appears to focus on the development of vocabulary. Students are expected to be able to recognize and name various two- and three-dimensional geometric figures, as well as some of their basic properties. This is the type of content which was included in the Geometric Figures objective; and, in the opinion of the Interpretation Panel, students' performance on such tasks was Satisfactory.

Performance levels on the other objective in the geometry domain, Geometric Relationships, was somewhat poorer, and was judged to be Marginal. Of the 18 items corresponding to this objective, 17 had results rated Satisfactory or Marginal. The items in this set covered topics such as spatial reasoning, properties of geometric figures, and symmetry.

The general picture which emerges with respect to students' performance in geometry is rather disappointing. Of the 36 geometry items 28 had results which were rated either Satisfactory or Marginal. It is true that several of the items dealt with topics from transformational geometry, which may not be emphasized by many teachers; however, in spite of that, the Interpretation Panel felt that performance levels should have been better than they were.

Teachers tend to give geometry lower priority in their teaching than other areas of the mathematics curriculum, and they should give it a more prominent role. Indications are that increased emphasis will be given to geometry in the new curriculum, and there may be a need to set up professional development courses or workshops for teachers in the teaching of geometry.

Measurement

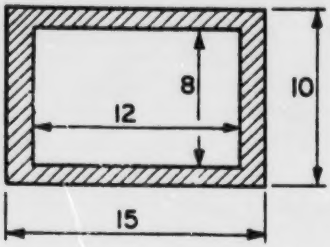
Results in this domain were rated Marginal, as were those for each of the two objectives: Metric Units; and Perimeter, Area, and Volume. Students did not perform particularly well, and this is unfortunate because measurement is one area of mathematics that has many applications in everyday life. There were 15 items included in the Measurement domain, and only three produced results which were rated higher than Satisfactory. In fact, nine of these item-results were rated either Marginal or Weak.

Results from the items in the *Metric Usage* scale, which were discussed earlier, indicate that a large proportion of students do not use metric units of measurement in everyday situations: in almost every case, a majority of students indicated a preference for the alternative expressed in Imperial units. Similar behaviour was evident on the achievement items. For example, when asked to select an appropriate temperature for "a sunny summer day," only 50% of Grade 7 students chose 25°C, and almost one-fourth chose 85°C. Similarly, only 51% chose 35 kg as an appropriate weight for a ten-year-old boy, and slightly more than 25% chose 75 kg: a highly improbable answer.

The fact that students are still unfamiliar with the use of metric units, despite the fact that teaching materials authorized for use in the schools have been 100% metric for years, seems undeniable, and it raises important questions. For example, we need to assess the degree of commitment of our society as a whole to the use of the metric system. Students are in school for only a portion of each day, and it is not reasonable to expect them to learn only the metric system, unless other segments of Canadian society agree to do the same. We have witnessed recently a certain amount of backing away from decisions taken several years ago about the changeover to the metric system, and these Assessment results show little improvement in students' knowledge of the metric units since 1981.

Grade 7 students are expected to be able to calculate areas and perimeters of triangles and rectangles, and to find volumes of rectangular prisms. The Interpretation Panel rated performance on the six items corresponding to this objective Marginal, and an example of an item which students found particularly difficult is shown below.

T/44 What is the area of the shaded portion of this figure?



		% of students
A	54	30 *
B	96	27
C	120	9
D	60	11
E	I don't know	20

This item is a difficult one, admittedly, because it is a multi-step problem. In order to obtain the solution, students must find the areas of two rectangles and their difference. More than one-third simply chose the area of one or the other of the two rectangles as their response. Moreover, 20% of them had no idea how to proceed, and chose the "I don't know" option.

Algebraic Topics

The 24 items in this domain were divided between two objectives: 18 for Expressions, Equations, and Inequalities; and 6 for Graphs. The Interpretation Panel rated students' performance Satisfactory.

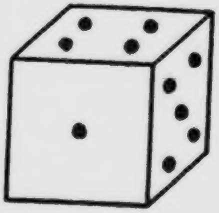
In general, students performed well on items dealing with the use of variables in expressions and with the translation of English expressions into algebraic ones. For example, 70% chose $n + 5$ as a representation for the phrase, "a number increased by 5." Results on items which involved more formal algebraic techniques, such as solving equations, were not as good: Only 45% were able to give 6 as the solution to the equation $2n + 8 = 20$. Given the content of the present curriculum and the contents of the authorized textbooks, these performance levels are not surprising.

Performance on items involving graphs was rated Very Satisfactory, the only objective or domain in Grade 7 to receive such a high rating. Five of the six item-results for this objective were rated higher than Satisfactory by the Interpretation Panel, a most gratifying outcome. The items dealt with the interpretation of information presented in the form of bar graphs, line graphs, and circle graphs.

Probability and Statistics

Neither probability nor statistics is included explicitly in the Grade 7 mathematics curriculum at the present time, although many textbooks contain chapters or units on these topics. Students showed some familiarity with basic concepts of probability as illustrated by Item S/17.

S/17 If on the roll of a die the probability that a five will appear is 1/6, then the probability that a five or a three will appear is:



		% of students
A	1/6	21
B	1/36	4
C	1/3	47 *
D	1/12	14
E	I don't know	14

The rate of "I don't know" responses to this item was fairly high; however, of those who chose one of the four possible answers, over 60% selected the correct one. This indicates, as did results on some of the other items, that many students have some understanding of elementary concepts of probability and, more importantly, that students of this age and grade level can work with these notions.

Some of the statistics items dealt with organization of data into frequency tables and finding the average of a set of numbers. Students did reasonably well on these items. Not surprisingly, they had more difficulty with items which made use of statistical terms such as *median* and *mode*.

Computers and Calculators

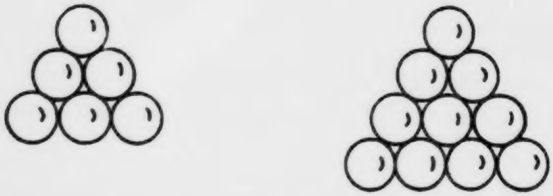
Neither of these topics is included in the present mathematics curriculum, although the Curriculum Guide does contain a note encouraging teachers to make use of calculators where they deem it appropriate to do so. The six items used to assess students' familiarity with computers and calculators dealt with elements of programming, terminology, and the outcomes of sequences of keystrokes on a calculator. In other words, they were sets of achievement items, and not attitude scales.

Students performed very well on the computer items, showing a fairly high degree of familiarity with basic terminology and programming concepts. They performed less well on the calculator items, and particularly those that required them to predict the outcome of a given sequence of keystrokes. Some of these involved the use of memory keys, and it may be that students have not had much experience with using memory functions on calculators.

Problem Solving

Performance on the set of items in this domain was rated Satisfactory. Most of these items were non-routine problems, and students would have had to find an appropriate strategy to use in order to find the correct answer. Most did not require any difficult computation to be performed. An example of one of these items, one on which students performed rather well, is shown below.

R/17 Marbles are arranged in the shape of a triangle on the floor. How many marbles are there in a triangle with 7 marbles in the base?



		% of students
A	12	10
B	28	65 *
C	42	5
D	49	6
E	I don't know	15

Problems such as this would not be included as core material in most textbooks, although they might be included as enrichment activities. Thus, many students would never have encountered such a problem, and this may explain why 15% chose "I don't know" as their answer. On the other hand, this is a fairly difficult item, and a success rate of 65% is very good indeed. Altogether, seven of the nine item-results were rated Satisfactory or Very Satisfactory.

Q-form Results

The items in the Grade 7 *Q*1 booklet dealt mainly with measurement: in particular, with the use of a ruler and a protractor. Each student was provided with a double-scale protractor and a 15-cm ruler which was also graduated in inches. Most students indicated that they owned their own rulers and protractors, but less than half reported using them in school to measure distances or angles.

About 90% correctly measured the length of a given line segment to the nearest centimetre; but less than 70% were able to do so to the nearest millimetre. There appeared to be a good deal of confusion among students as to the correct symbols for the metric units.

Approximately 50% of students were able to measure the size of an angle to the nearest degree, and 60% were able to draw an acute angle given its measure. Students appear to need more practice in the use of rulers and protractors, and Grade 7 teachers should not assume that these skills have been mastered in earlier grades.

*Q*2-form results showed satisfactory levels of performance in computational skills, although a difficulty with order of operations was noted. For the problem-solving items, the most commonly employed strategy was drawing a diagram. The second was writing an equation. The most difficult problem in the set was Item 20, which was answered correctly by 46% of students.

> There are 6 fence posts on one side of a garden. The fence posts are 2 m apart. What is the distance from the first post to the last post?

Grade 10 Results

Table 3-4 contains a summary of information concerning the 150 achievement items included in the regular Grade 10 Assessment booklets. No ratings are provided for the Probability and Statistics, and Computers and Calculators domains because they dealt with content which is not part of the required Grade 10 mathematics curriculum.

Table 3-4
Grade 10: Summary Statistics

Domain/Objective	Number of Items	Provincial Mean (%)	Panel Rating
Number and Operation	36	58	M
Number Concepts	9	48	M
Fractions and Decimals	15	62	S
Ratio, Proportion & Percent	12	61	S
Geometry	24	47	M
Geometric Figures	9	47	M
Geometric Relationships	15	46	M
Measurement	21	55	S
Metric Units	6	69	S
Perimeter, Area & Volume	15	50	S
Algebraic Topics	30	52	M
Expressions, Equations & Inequalities	21	48	M
Graphs	9	60	S
Probability and Statistics *	15	41	-
Probability	6	54	-
Statistics	9	33	-
Computers & Calculators *	15	45	-
Computer Literacy	6	40	-
Calculator Use	9	48	-
Problem Solving	9	42	S

* Non-curricular domain.

These results, and particularly the ratings given by the Interpretation Panel, are rather negative. Results in three of the major content domains--Number and Operation, Geometry, and Algebraic Topics--were rated Marginal, and no objective or domain resulted in a performance level rated higher than Satisfactory. In other words, the Interpretation Panel had serious concerns about Grade 10 students' performance on this Assessment.

Part of the explanation for these relatively poor results may be found by examining the prescribed curriculum for Mathematics 10. That course, as defined in the current

Curriculum Guide, is made up of a number of strands corresponding to several of the domains defined for this Assessment. There is a considerable amount of evidence which suggests that there are large differences between that official curriculum and what is actually taught in classrooms. Many schools stream students for mathematics at this level, with the better-prepared students taking what amounts to a full year of algebra, and the weaker students some form of General Mathematics course. The implication of this state of affairs is that there is in fact no such thing as a Mathematics 10 course. Instead there are many different courses, each emphasizing different components of the prescribed curriculum.

In this Assessment students were asked to indicate what type of Mathematics 10 course they were enrolled in, and an analysis of performance levels by type of course taken raises even more concerns. The data show that students enrolled in a General Mathematics course did more poorly than those taking a regular Mathematics 10 course. This was the case in every domain, not just in the Algebraic Topics domain, which would not be emphasized in a General Mathematics class; but also in the Number and Operation domain, which would typically be the major focus of such a course. It is difficult to assess the impact of these modified courses, because there is no prescribed curriculum for them: most have been developed at the school level. The Ministry of Education should investigate the nature of these courses and the streaming practices employed, with a view to standardizing them for all schools.

Number and Operation

Grade 10 is the last year in which students are required to take a mathematics course at the present time. All students are expected to complete the Mathematics 10 course and, among other things, to demonstrate a mastery of basic arithmetic concepts and skills such as those included in the Number and Operation domain in this Assessment. The fact that the Interpretation Panel assigned a Marginal rating to students' performance in this domain should be a cause for concern, particularly because this domain focuses on basic arithmetic concepts and skills and their applications.

In general, students' performance was Satisfactory on items involving computational skills; but, on those which required them to use such techniques to solve problems, it was frequently lower. For example, the Interpretation Panel considered the results on Item R/40 to be Marginal, since only 59% of students were able to select the correct response to what appears to be a simple application of percent.

R/40 The sales tax is 5%. How much would the sales tax be on a new car that costs $6750.00?

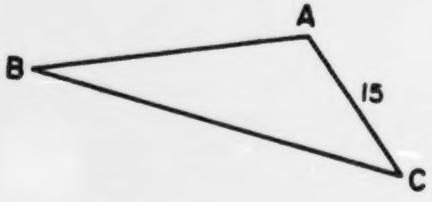
		% of students
A	$675.00	6
B	$337.50	59 *
C	$ 67.50	9
D	$ 33.75	11
E	I don't know	9

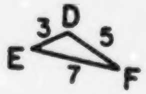
Geometry

Performance in the Geometry domain was also rated Marginal. Students had difficulty with terminology. For example, only 54% correctly identified a pair of perpendicular lines; 48%, a pair of corresponding angles; and 23%, the altitude of a triangle. However, they did considerably better on items requiring them to visualize an object in space.

Many students demonstrated a lack of knowledge of some elementary results in geometry, such as the equality of vertical angles, the sum of the angles of a triangle, and properties of parallel lines and congruent figures. They also had difficulty with items dealing with similar triangles as shown in the following example.

S/42 Triangle ABC is similar to Triangle DFE. Find the length of segment BC.





		% of students
A	21	55
B	15	5
C	35	21 *
D	47/5	2
E	I don't know	11

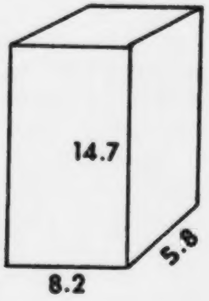
The Interpretation Panel felt that the teaching of geometry was being neglected by many teachers, and that it was either relegated to the very end of the course or not taught at all. They re-iterated the recommendation made after the 1981 Assessment that increased emphasis and attention be given to this important domain.

Measurement

Performance levels in the Measurement domain were deemed to be Satisfactory. Students demonstrated a good grasp of metric units and did very well on items which required them to estimate measurements in metric units. They did less well on items which required them to convert from one unit to another within the metric system.

The Curriculum Guide stipulates that students should be able to calculate perimeters, areas, and volumes of a number of types of geometric figures, given the appropriate formula. Formulas were not provided in the Assessment booklets and this likely accounts for the rather low scores recorded on several such items. Students also had difficulty with items requiring them to estimate. For example, on Item S/25 only 39% selected the correct answer, a result rated Marginal.

S/25 The best estimate for the volume of the solid shown below is:



		% of students
A	29	10
B	56	10
C	550	25
D	720	39 *
E	I don't know	15

Algebraic Topics

The Interpretation Panel was generally disappointed with the level of achievement in this domain, particularly in view of the importance given to the study of algebra in the mathematics curriculum for Grades 9 and 10. They suggested that a reorganization of that curriculum was required to give appropriate emphasis to topics such as the solution of linear equations and the use of formulas. As an example of the latter, students had difficulty with items involving applications of the simple interest formula. Their performance on Item R/45 was rated Marginal.

R/45 The formula used to calculate simple interest is $i = Prt$ where i is the interest, P is the principal, r is the rate, and t is the time in years.

Using the formula shown above, find the interest on a principal of $1000 invested for two years at an annual rate of 7%.

		% of students
A	$ 140	41 *
B	$1400	16
C	$ 70	11
D	$ 14	6
E	I don't know	15

Performance was somewhat better on items dealing with graphs, and was judged to be Satisfactory overall. Students did well on items requiring them to interpret information presented in the form of a graph, but less well on more strictly algebraic topics such as finding the slope of a line, or recognizing the graph of a linear equation in two variables.

Probability and Statistics

Probability and statistics are not part of the core curriculum for Grade 10, but they are included as possible optional units in the current Curriculum Guide. Students demonstrated a fairly good intuitive grasp of elementary notions of probability, but did less well on items requiring familiarity with specific concepts or terms. Most item-scores were not particularly high and, given the ever-increasing need for all citizens to be able to interpret statistical data and results, it seems clear that increased attention should be given to these topics in the future.

Computers and Calculators

The items used in this domain at the Grade 10 level were, for the most part, exactly the same as the ones used in Grade 7. It is interesting, therefore, to note that there was not much difference between the scores obtained by students in

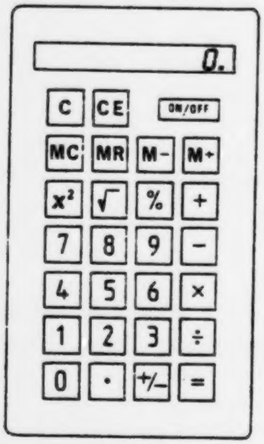
Grade 7 and those in Grade 10 on the Computer Literacy items, and a difference of 10 percentage points in favour of Grade 10 on the Calculator Use items. Insofar as levels of performance on these items are concerned, and especially on the calculator items, it appears that many students have not had much experience, and would benefit from some systematic treatment of the topic. For example, results on Item S/23 demonstrate a widespread lack of familiarity with the operation of a typical calculator.

S/23

The following sequence of keystrokes is carried out on the calculator:

$\boxed{6}\,\boxed{3}\,\boxed{+}\,\boxed{7}\,\boxed{\text{CE}}\,\boxed{6}\,\boxed{=}$

What will likely be shown in the display?



A. 6.

B. 69.

C. 76.

D. 636.

E. I don't know.

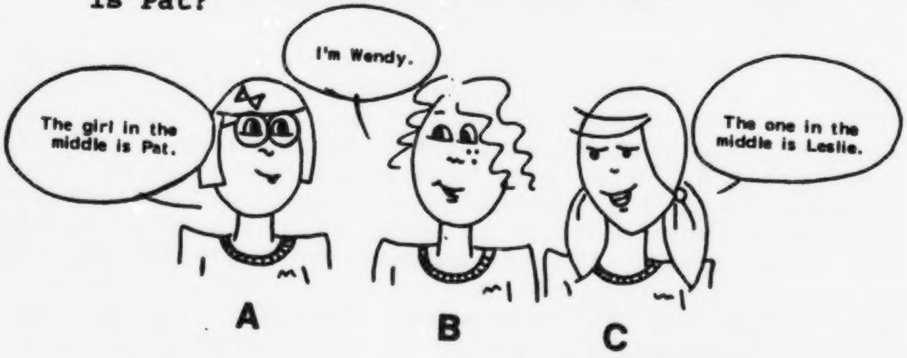
		% of students
A	6.	47
B	69.	25 *
C	76.	10
D	636.	3
E	I don't know	14

The Interpretation Panel recommended that a computer literacy curriculum for use in Grades K-12 be developed, and that a unit on the use of calculators be made a part of the Grade 9 curriculum. They also recommended that increased emphasis be given to the topic of estimation.

Problem Solving

None of the nine items included in this domain lent themselves to solution by means of the application of a standard algorithm or procedure. In each item students were presented with a problem which could be solved only through the use of more general problem-solving strategies or heuristics. Item R/43 is a sample of the items included in the Problem-Solving domain, and the Interpretation Panel judged students' performance on this item to be Very Satisfactory.

R/43 Three tennis players named Pat, Wendy, and Leslie are walking to the courts. Pat, the best player of the three, always tells the truth. Wendy sometimes tells the truth, while Leslie never tells the truth. Who is Pat?


The girl in the middle is Pat.
I'm Wendy.
The one in the middle is Leslie.
A
B
C

		% of students
A	A	9
B	B	12
C	C	46 *
D	Either A or B	15
E	I don't know	10

Q-form Results

The Grade 10 *Q*1 form focussed on students' understanding of algebraic concepts and operations. Their performance was generally good on most of the straightforward items, bearing in mind the fact that this was a biased sample of students. Some items, however, proved to be more difficult--for example, which is larger $2n$ or $n + 2$--and these tended to be items which dealt with understanding of concepts such as that of a variable. Students might profit from more exposure to the use of variables in expressions and functional relationships, where the variable may assume a number of values, as opposed to their use in linear equations, where students are expected to find the single value of the variable which satisfies the algebraic condition.

On the *Q*2 form, students performed satisfactorily on the computational items and on more or less routine story problems. A few items, including Item 18 shown below, proved to be surprisingly difficult, however.

> A litre of asphalt paint will cover about 6 m^2 of surface. The paint is sold in cans of 5 litres only. How many cans are needed to paint a driveway 15 m long and 3 m wide?

Only 43% of students were able to solve this problem, and many of them translated 6 m^2 to 36 m, thereby demonstrating a lack of understanding of the use of the exponent in the metric unit.

Background Factors and Achievement

In each Mathematics Assessment, information about certain aspects of students' backgrounds, opinions, and future plans has been collected. Some of this information has been used strictly for the purpose of describing characteristics of the population of students in our schools, while other data has been used to investigate variations in achievement patterns. Such data were collected once again in this Assessment, and the following is a brief summary of the relevant findings.

Sex Differences in Achievement: Grades 4, 7, and 10

The following quotations concerning sex differences in mathematics achievement are taken from the Summary Reports of the 1977 and 1981 Mathematics Assessments, respectively:

> Female students outperformed males on most of the computation objectives on all three tests, while males outperformed females on all of the problem-solving objectives. Most such differences, whether in favour of males or females, were small. (Robitaille and Sherrill, 1977, page 3)

> Differences in achievement generally favoured males over females, as they did in 1977. While these differences were small at Grade 4, they were substantial at Grade 12. (Robitaille, 1981, page 2)

The findings from the 1985 Assessment are similar to those from the two previous studies, but there does appear to be a lessening of the achievement gap between the two sexes. In Grade 4 the differences in achievement results between males and females were very small: no domain score differences exceeded 3 percentage points. In Grade 7, boys' and girls' scores on the three most heavily weighted domains--Number and Operation, Algebra, and Geometry--were identical. The greatest difference, 4 percentage points, occurred in Measurement, and it favoured the boys. In Grade 10, boys outperformed girls on every domain except Algebra, where the scores were equal. Most of these differences were less than 5 percentage points.

From a statistical point of view, since these results are based on a census of the entire population at each grade level, any differences between the two groups would be regarded as significant. From an educational point of view, however, differences of this magnitude would not seem to be great enough to matter. Although males outscored females in several domains at each grade level, all of these differences were small.

Effects of Streaming: Grade 10

The Curriculum Guide prescribes only one course for each of Grades 8, 9, and 10: all students are expected to follow the same curriculum in mathematics until the end of the junior secondary grades. In fact, almost all secondary schools have more than one course at these levels, usually referred to as Regular or Academic Mathematics and General or Modified Mathematics. Students who plan to enroll in Algebra 11 are channeled into the former, which includes a great deal of work in algebra. The General or Modified courses, on the other hand, devote less attention to algebra.

An analysis of Grade 10 results on the basis of the type of course in which the students were enrolled reveals that students in the General Mathematics classes do much more poorly than those in the Regular classes in every domain. On the Number and Operation, Geometry, Measurement, and Algebraic Topics domains, those differences were 22, 18, 19, and 25 percentage points, respectively. Such large differences on the Algebraic Topics and Geometry domains are perhaps to be expected given the nature of the courses involved, but those on the other two domains are very disturbing. These are the very topics on which typical courses in General Mathematics are concentrated, and it therefore seems clear that these General or Modified Mathematics courses are not achieving the goals for which they were intended.

Semestered versus Non-semestered Classes: Grade 10

Students in full-year courses did slightly better than those in semestered courses in all of the domains except Computers and Calculators, but none of the differences exceeded 3 percentage points. The Assessment was conducted before the end of the second semester, so these differences may be attributable to the fact that students in second-semester classes had not completed as much of the course as had those in full-year classes.

References

Robitaille, D.F., and Sherrill, J.M. (1977) *The B.C. Mathematics Assessment: Summary Report*. Victoria, B.C.: Ministry of Education.

Robitaille, D.F. *The 1981 Mathematics Assessment: Summary Report*. Victoria, B.C.: Ministry of Education.

4. THE TEACHERS OF MATHEMATICS

Questionnaires dealing with background information, the teaching of problem solving, topics in the curriculum, and the uses of Calculators and Computers were administered to teachers as part of the Assessment. Completed questionnaires were obtained from 1304 Grade 4 teachers, 1044 Grade 7 teachers, and 686 Grade 10 teachers.

Teacher Background

At all three grade levels, teachers reported a median of 11 to 15 years of experience teaching mathematics. Compared to results from previous Assessments, this indicates a trend toward an aging cohort of mathematics teachers. This is most marked at Grade 10, where 39% of teachers had more than 15 years of mathematics teaching experience. This trend is undoubtedly a result of a decline in the number of teaching positions available in many school districts. Fewer mathematics teachers are being hired, and those who have teaching positions are staying on longer.

The typical Grade 4 teacher teaches mathematics every day for about 40 minutes, but many spend more time than that. In Grade 7, there is some degree of specialization: some teachers teach more than one mathematics class. About 50% of Grade 10 teachers teach mathematics almost exclusively; they are specialists in the subject. On the other hand, 25% teach only one or two mathematics classes.

Almost all elementary programs are taught on a full-year basis, whereas 16% of Grade 10 classes are on a semester system. About 6% of the Grade 4 and 7 courses had been modified for slower students; and 4%, enriched. In Grade 10, 25% of courses had been modified for slower students, and 11% enriched.

The typical elementary teacher has completed one or two post-secondary mathematics courses and one or two mathematics education courses. The typical Grade 10 teacher has completed ten or more mathematics courses, and one or two mathematics education courses. These results, particularly at the secondary level, indicate that teachers have fairly good academic preparation in mathematics. On the other hand, since 1977, there has been an increase in the proportion of teachers at all three grade levels who have taken no mathematics education courses. This phenomenon is also prevalent in the United States, and much attention has been given to the problem of what are called "crossover" teachers; that is, teachers who are assigned to teach mathematics even though they have been trained in a different specialty.

About 50% of Grade 4 and 7 teachers, and 56% of Grade 10 teachers, had attended a mathematics session at a conference within the last three years. These rates of attendance are down slightly from previous years. About 58% of elementary teachers and 63% of secondary teachers reported that they had attended a workshop or in-service day in mathematics, other than at a conference, in the last three years. These figures are up slightly from 1981 and are virtually the same as in 1977.

Membership in professional organizations related to mathematics education remains low. Fewer than 5% of Grade 4 and 7 teachers belong to the British Columbia Association of Mathematics Teachers, the National Council of Teachers of Mathematics, or a local specialist association for mathematics teachers. Among Grade 10 teachers, membership in these organizations is much higher, but still lower than might be expected for a group of mathematics specialists: 27%, 13%, and 19% belonged to the three organizations, respectively.

Teachers were asked to describe the activities in which students were engaged during a mathematics class. Reported student activities were surprisingly similar across grades. Typically, students were engaged in individual seatwork about 40% of the time, regardless of grade level. About 60% of teachers at all grade levels reported no students working in small groups, while about one-third said that students worked in small groups up to about one-quarter of class time. Stations and activity centres were used more in the lower grades, but even at the Grade 4 level, over 80% of teachers did not use these teaching approaches.

Mathematics in School

On the *Mathematics in School* scale, ten topics from the curriculum at each grade level were listed. Teachers were asked to indicate on a 5-point scale how important they felt each topic was, how easy it was to teach, and how much they enjoyed teaching it. Possible responses ranged from Not at all Important to Very Important; Very Easy to Very Difficult; and Dislike a Lot to Like a Lot.

While Grade 4 teachers indicated that all the topics listed were important, they felt the least important were learning about fractions, learning about decimals, and learning about squares, rectangles, and triangles. There were relatively few highly positive responses on any of the three dimensions. The only exceptions occurred on the importance scale, and the five topics rated very important were operations on whole numbers, learning about the metric system, checking answers, solving word problems, and learning place value. More than 50% of teachers rated these items very important, thereby indicating very definite positive opinions.

Grade 4 teachers were also quite consistent in their enjoyment of each topic; over 70% rated the topics as enjoyable to teach. The best-liked topic was operations on whole numbers, on which 95% of the teachers indicated a positive attitude. These attitudes are corroborated by the results on one of the background items, on which only 2% of Grade 4 teachers indicated that they would avoid teaching mathematics altogether if they had the choice.

There was much greater variability in Grade 4 teachers' responses on the easiness scale. Teachers felt that solving word problems was the most difficult of all topics to teach, and only 21% said it was easy or very easy. The other difficult topic was getting students to check answers. The two easiest topics were teaching about squares, rectangles, and triangles; and using graphs.

Grade 7 teachers viewed all topics as important. The least important was geometry, and more teachers were undecided on this item than on any other item. Four topics were rated very important by more than 50% of teachers: operations on decimals, working with percent, memorizing basic facts, and solving word problems. Of these, the highest rating was given to operations on decimals, followed by solving word problems. Geometry was ranked last in importance.

Grade 7 teachers indicated that, in general, they liked teaching the topics. They were least favourably disposed toward teaching basic facts. About 70% reported that solving word problems was a difficult topic to teach. The next most difficult was solving equations, which about 50% rated difficult to teach.

Grade 10 teachers also rated most topics as important. The most important topics were solving equations and solving word problems, and over half the teachers rated these as very important. The two items related to geometry were rated least important, indicating once again that geometry is not seen as having a very high priority in the curriculum.

Most Grade 10 teachers liked teaching all of the topics in the list, and their favourite was solving equations. The least-liked topics dealt with geometry and numerical computation. The most difficult topic to teach was solving word problems, rated difficult or very difficult by 76% of teachers.

In general, geometric topics were consistently rated as important by fewer teachers at all grade levels, and teachers at the upper grade levels viewed the topic as even less important than those at lower levels. On the other hand, teachers did not see geometric topics as particularly difficult to teach, nor did they indicate that they disliked teaching them.

Problem Solving

Problem solving is an area that is currently of great concern to teachers and curriculum developers. One entire scale on the teacher questionnaire was devoted to finding out teachers' opinions on their teaching of problem solving, and the resources available for that purpose. Teachers were also asked to express their degree of agreement with a number of statements on problem solving.

Teachers at all grade levels were more negative than positive with respect to their students' enjoyment of, and ability in, problem solving, and there was a trend on both items for teachers to be more negative at higher grade levels. For example, only 18% of Grade 10 teachers felt that most of their students enjoyed problem solving, and only 24% reported that most of their students performed well in problem solving.

Most teachers, including a relatively large 30% who strongly disagreed, did not feel that the textbooks they used provided adequate instruction for developing problem-solving skills. Many teachers were undecided when asked whether their district provided adequate assistance and resources for the teaching of problem solving; but, even at Grade 4 where the level of satisfaction was highest, only 39% of teachers saw district resources as adequate. Only 25% of Grade 10 teachers were satisfied with the resources and assistance provided by their district.

About half the teachers were satisfied with their own teaching of problem solving, but few found it easy. Levels of satisfaction seemed to be somewhat less in elementary school than at Grade 10.

About half the elementary teachers agreed that teachers should attend an annual workshop on problem solving. On the other hand, when asked how many workshops on problem solving they had attended in the past year, about 75% of teachers at each grade level said "none," and about 20% had attended only one.

Teachers at all levels reported that the most widely-used activity to motivate students was the use of puzzles or brain teasers. Competitive games were popular at Grade 4, but their use decreased with increasing grade level. Teachers were also asked about the kinds of problem-solving activities they set up in class. Elementary teachers favoured having students make up problems and having problem-solving contests in class. Fewer Grade 10 teachers reported using problem-solving activities, but about 20% set up a puzzle of the week and had problem-solving contests in class.

Teachers at all levels reported using a variety of problems, such as ones which contained too much or too little information, or which could be solved in more than one way. They also reported teaching a variety of problem-solving approaches, including such heuristics as look for a pattern, guess and check, make a systematic list or table, solve a simpler problem, and work backwards. In evaluating solutions, most teachers gave partial credit to students who produced an appropriate diagram or equation, or showed a correct procedure.

On the *Mathematics in School* scale, the one topic on which teachers were agreed was problem solving. At all three grade levels this topic was seen by teachers to be very important and very difficult to teach, but not particularly disliked. Students, on the other hand, were much less favourably disposed to solving word problems.

Much needs to be done to help teachers do a better job of teaching problem solving. At the present time teachers do not perceive that their students enjoy or are very successful at problem solving, they are not satisfied with their textbooks and district-level resources, and they are not particularly satisfied with their own teaching of the topic. Workshops which stress problem-solving approaches of demonstrated effectiveness might be of particular benefit to teachers.

Calculators and Computers

Almost all teachers own calculators: Grade 4, 91%; Grade 7, 96%; and Grade 10, 97%. Teachers use them extensively both inside and outside the school for non-teaching purposes including calculating students' grades, checking assignments, and preparing worksheets. In spite of this, the majority of Grade 4 teachers, 35% of Grade 7 teachers, and 15% of Grade 10 teachers said that they did not permit students to use calculators in class.

In classes where calculators were permitted, Grade 4 students used them mainly for drill and practice to enhance computational skills, while Grade 7 and 10 students used them mainly to work on problems. In about half of these classes at each grade level, students used calculators occasionally for estimating and finding patterns.

Almost all Grade 10 students, and over half of Grade 4 students own calculators, and most students use their calculators outside school. Virtually all teachers own calculators, and use them both inside and outside school. The schools cannot ignore this technology and should be considering ways to improve the teaching and learning of mathematics through the use of calculators. The revised curriculum should make calculator use mandatory for all students.

Computers seem to have been much more readily accepted in schools than have calculators, perhaps because they do not appear to conflict so obviously with the general thrust of the curriculum. Teachers were asked whether they owned computers and ownership rates for Grades 4, 7, and 10 teachers were 21%, 24%, and 34%, respectively. Very few teachers said that they had had no experience with computers. More than half the Grade 7 and 10 teachers had experience with each of games, word processing, computer-assisted instruction, and programming. Grade 4 teachers were less familiar with programming.

In response to an item dealing with the type of computer organization in school, almost all teachers said there were computers in their schools, and very few said that computers were used for administrative purposes only. The most common type of organization was one in which computers were provided in one or more places for use by teachers with their students: 62% of elementary teachers, and 55% of Grade 10 teachers.

Half of the Grade 4 and 7 teachers and three-quarters of Grade 10 teachers did not use computers in their mathematics classes. However, almost half of the Grade 4 teachers had students use software packages. About 20% of Grade 7 teachers had students learn computer programming. Approximately 10% of teachers at all levels used computers to demonstrate concepts.

About half of the teachers at all levels believe it is essential that computers become an instructional tool for teaching mathematics. Moreover, about 60% believe that nearly everyone will need computer skills to be successful in society. Given that about 90% of mathematics teachers have had some experience with computers, and that 20% to 30% have computers at home, it would seem that a very favourable climate for computer education in mathematics is in place. Moreover, just about every school in the province now has at least one computer. What now appears to be needed is the identification and development of appropriate software to augment instruction in mathematics.

5. Conclusion and Recommendations

A project as comprehensive as this Mathematics Assessment produces many findings. Some of these are more important than others and deserve special comment. The members of the Contract Team have considered the findings at each grade level in detail, and have reached a number of conclusions about the current state of mathematics education in British Columbia. The goal of the present chapter is to present a number of recommendations to those persons whose responsibility it is to see to the continuing improvement of the teaching and learning of mathematics in the schools of this province.

The 1985 Mathematics Assessment was structured along very much the same lines as the ones conducted in 1977 and 1981, and many of the findings have a familiar ring. There is a certain sense of *déjà vu* about many of the findings and, consequently, about the recommendations as well. It might be appropriate now, in view of the experience gained over the past three Mathematics Assessments, to re-examine the goals and objectives of these large-scale evaluation projects to ensure that they are still viable.

In both the 1977 and 1981 Assessments, specific recommendations were directed at areas which were considered to need improvement. Many of those same areas have been identified once more in 1985, and there is some doubt whether any action has been taken in the interim. If Assessments are to be of some help in improving the educational system, and if the large amounts of money expended on them are to be justifiable, then recommendations should be acted upon, or the reasons for not taking action should be made clear.

It must be acknowledged that the 1981 report was written in anticipation of the more or less imminent introduction of a revised mathematics curriculum, K-12. We find ourselves now, in late 1985, with the same curriculum we had in 1981 and, in fact, the same one we had in 1977. The Contract Team understands that it is difficult to implement recommended changes in emphasis or pedagogical approach in the context of an existing curriculum. Teachers are still using the same authorized textbooks, and must rely on their own devices if they are to make changes. We are hopeful that the new curriculum, soon to be introduced, will incorporate many of our recommendations, particularly those which have been made more than once.

In the 1985 Mathematics Assessment, booklets consisting mainly of open-ended items were utilized in addition to the three regular Assessment booklets at each grade level. This innovation has, in the opinion of the Contract Team, proved to be a rich source of data, much of which is still being analyzed. The goals of the Learning Assessment Program might be better served, in future Assessments, by placing greater emphasis on this type of evaluation.

RECOMMENDATION 1

We recommend that the Ministry of Education re-examine the goals and objectives of the Learning Assessment Program, and that the use of evaluation strategies designed to assess the cognitive processes utilized by students be considered for inclusion in all future assessments.

The Contract Team is concerned about students' performance in geometry and about teachers' and students' rating of geometry as the least important of the topics on the *Mathematics in School* scale. We understand and expect that geometry will play a more prominent role in the revised curriculum, and we are hopeful that teachers will be provided with the materials they need to teach this geometric content well.

RECOMMENDATION 2

We recommend that increased emphasis be given to the study of geometry at all grade levels, and that in-service programs in the teaching of geometry be made available to teachers.

Results from the *Metric Usage* scale show that, in several practical situations, the majority of students at all three grade levels continue to use Imperial units of measure rather than SI metric ones. Moreover, achievement results in the measurement domain reveal a degree of weakness in students' ability to convert from one unit to another within the metric system.

RECOMMENDATION 3

We recommend that teachers in all subject areas make a determined effort to use metric units exclusively in their teaching, and that conversion of units within the metric system be given increased emphasis.

We further recommend that the Ministry of Education use its influence and good offices with other governmental agencies and departments to ensure that the metric system of measurement is used exclusively in business and consumer applications.

In the 1981 Assessment it was found that teachers, particularly at the lower grade levels, were making little use of calculators or computers. A recommendation was made at that time that the question of calculator and computer use in schools be treated as a priority matter, but little appears to have been done. The situation in the schools in 1985 appears to be very much the same in this regard.

RECOMMENDATION 4

We recommend that, in the forthcoming revision of the mathematics curriculum, emphasis be given to appropriate uses of calculators and computers in the teaching of mathematics, and that a computer literacy program, separate from the mathematics curriculum, be developed and implemented for Grades K-12.

At all three grade levels assessed, results showed that students have difficulty dealing with concepts and operations involving common and decimal fractions. All of the Interpretation Panels in 1981 and 1985 referred to this problem, and a recommendation for increased attention to this area was made in 1981. The situation appears not to have changed in the interim.

RECOMMENDATION 5

We recommend, therefore, that the Curriculum Revision Committee pay particular attention to the development of rational number concepts and of computational skills with rational numbers expressed either as common or as decimal fractions. We recommend, in particular, that decimal concepts and operations be introduced in the lower grades before the corresponding work with common fractions, in order that teachers may take advantage of students' knowledge of place-value concepts with whole numbers.

Students' performance in the *Problem Solving* domain indicates that their ability to solve non-routine problems is in need of improvement. This situation is not surprising, since problem solving of this type is not explicitly included in the current curriculum guide, nor is it featured to any degree in most of the textbooks currently in use.

RECOMMENDATION 6

We recommend that the development of skills and strategies which can be used to solve non-routine problems in mathematics be a major focus of the revised curriculum at all levels. We further recommend that supplementary materials for the teaching of problem solving be made available to teachers for use with their students.

In both the 1977 and 1981 Mathematics Assessments it was pointed out that many teachers who had little or no background in post-secondary mathematics or mathematics education were teaching mathematics. If anything, the situation in 1985 is worse than it was in 1977, and it is imperative that steps be taken to remedy this situation immediately. It will not be possible to implement the new curriculum successfully unless the teachers involved have adequate academic and professional preparation.

RECOMMENDATION 7

We recommend that principals and school district personnel ensure that, regardless of grade level, only those teachers who have adequate preparation, both academic and professional, be permitted to teach mathematics. We also recommend that all Faculties of Education in British Columbia include, as compulsory components in their teacher education programs for prospective elementary teachers, a course in mathematics and one in methods of teaching mathematics.

Appendices

APPENDIX A

Members of Review Panels

Primary/Grade 4

Jan Barstow	Teacher	Richmond
Pat Henry	Teacher	Alberni
Kenzie Munn	Teacher	Saanich
Flo Pachel	Teacher	Cranbrook

Intermediate/Grade 7

Ray Asai	Teacher	Peace River North
Gail Cretelli	Teacher	North Vancouver
Grant DeWolf	Teacher	Castlegar
Doreen Jeffery	Principal	Kamloops
Don Van Kleek	Teacher	Sunshine Coast

Junior Secondary/Grade 10

Sharon Cairns	Teacher	Prince George
Sandra Garfinkel	Teacher	Vancouver
Tom Johnsone	Teacher	Nelson
Charles Morrison	Teacher	Campbell River
Bob Passmore	Teacher	Central Okanagan

APPENDIX B

Provincial Interpretation Panels

Grade 4

Laura Acton	Parent	Victoria
Sharron Clark	Parent	Nechako
Allan Douglas	Principal	Courtenay
Ellen Elliott	Teacher	Nanaimo Christian School
Helen Evans	Trustee	Powell River
Lionel Koh	Teacher	Armstrong
Leonard Kosiec	Teacher	Fernie
Gordon Milne	Principal	South Peace
Freda O'Sullivan	Teacher	Sooke
Marla Pickard	Teacher	Cariboo-Chilcotin
Jackie Simpson	Teacher	Surrey
Shirley Spiller	Trustee	Vernon
Sandra Verbeck	Teacher	Hope
Clive Williams	Teacher	Mission

Grade 7

Pat Aitken	Parent	Lillooet
Janet Anderson	Teacher	Prince Rupert
Steven Baker	Teacher	Terrace
Robert Belcher	Teacher	Sooke
Ian Cameron	Teacher	Armstrong
Len Fowles	Principal	Kamloops
Grace Fraser	Teacher	Burnaby
Richard Gage	Supervisor	Merritt
Peter Giltrow	Teacher	Coquitlam
Grant McDonald	Teacher	Windermere
Andrew Murray	Trustee	Abbotsford
Margaret Ormond	Trustee	Nelson
Patrick Reynolds	Teacher	Vancouver Island West
Lyn Skrlac	Parent	Port McNeill
Karen Susheski	Teacher	Surrey
Maureen Sutherland	Teacher	St. Michael's School Burnaby

Grade 10

Peter Bennett	Teacher	Penticton
H.E. Braunwarth	Teacher	Cowichan
Allan Davis	Trustee	Chilliwack
Keith Farnworth	Teacher	Grand Forks
Reg Fogarty	Teacher	Howe Sound
Barbara Glick	Teacher	Vancouver
Pat Meehan	Principal	Kitimat
Debbie Naka	Teacher	Penticton
Gry Nohr	Vice-Principal	Fort Nelson
Marion Ponzini	Parent	Delta
John Runke	Teacher	Nanaimo
Leslie Tombs	Parent	Qualicum
Keith Walker	Headmaster	Glenlyon School Victoria
John Woods	Teacher	New Westminster

APPENDIX C

Pilot Schools

Primary/Grade 4 Items (tested 57 grade 5)

School	District
Crescent Park Elementary	Surrey
Fruitvale Elementary	Trail
Happy Valley Elementary	Sooke
Malaspina Elementary	Prince George
Parksville Elementary	Qualicum
Robert L. Clemitson Elementary	Kamloops
Sooke Elementary	Sooke

Intermediate/Grade 7 Items (tested 57 grade 8)

School	District
College Heights Secondary	Prince George
Dunsmuir Secondary	Victoria
Earl Marriott Secondary	Surrey
Parksville Middle	Qualicum
Rossland Secondary	Trail
Valleyview Junior Secondary	Kamloops

Junior Secondary/Grade 10 (tested 57 grade 11)

School	District
Ballenas Secondary	Qualicum
College Heights Secondary	Prince George
Dunsmuir Secondary	Victoria
Earl Marriott Secondary	Surrey
J. Lloyd Crowe Secondary	Trail
Kamloops Secondary	Kamloops

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Assessment Update

DECEMBER 1985

1985 MATHEMATICS ASSESSMENT RESULTS

In May, 1985, approximately 95 000 students in Grades 4, 7, and 10 completed achievement surveys and attitude scales in the third British Columbia Mathematics Assessment. This update presents a brief summary of the results of this assessment and also presents comparative data for some of the countries that participated in the Second International Mathematics Study conducted during the 1980-81 school year.

HIGHLIGHTS

- The ratings given by the Interpretation Panels to the Grade 4 and Grade 7 results were generally positive. Grade 10 results were rated substantially lower.
- The most positive rating was given to the graphing section of the curriculum which was rated as very satisfactory at Grades 4 and 7.
- Performance in the following areas was rated as marginal at two of the three grade levels: Fractions and Decimals, Geometric Relationships, Metric Units, and Expressions, Equations and Inequalities.
- Significant numbers of students had difficulty using standard algorithms such as the one for long division with whole numbers.
- Students at all three grade levels had difficulty on items dealing with estimation.
- Grade 4 students in 1985 outperformed those in 1977 and 1981 on items which were common to the three projects. Such comparisons at the other two grade levels were not possible.
- Results from the International Study conducted in 1981 showed that Grade 8 students in British Columbia placed among the top third of the 20 participating countries, and higher than students from any other English-speaking jurisdiction. Performance of Grade 12 students in British Columbia compared favourably with that of students in Ontario and the U.S.A. Other comparisons at this level were difficult to make because of the differences in the populations that were tested in the different countries.
- Approximately 25% of Grade 10 students were enrolled in courses labelled General Mathematics or Modified Mathematics.
- Almost all students had regular homework assignments and most students spent less than half an hour on such assignments.
- Teachers expressed the opinion that more attention should be given to the teaching of problem solving in mathematics.
- Significant numbers of teachers at all three grade levels reported that they have had no post-secondary training in mathematics or in the teaching of mathematics.

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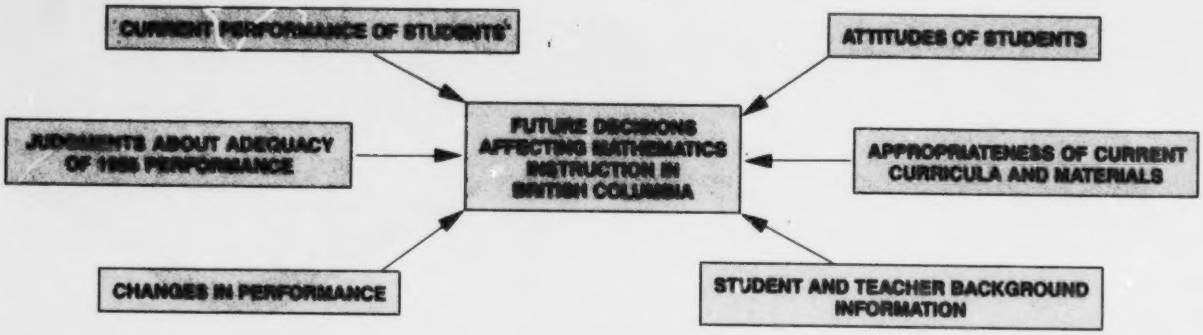
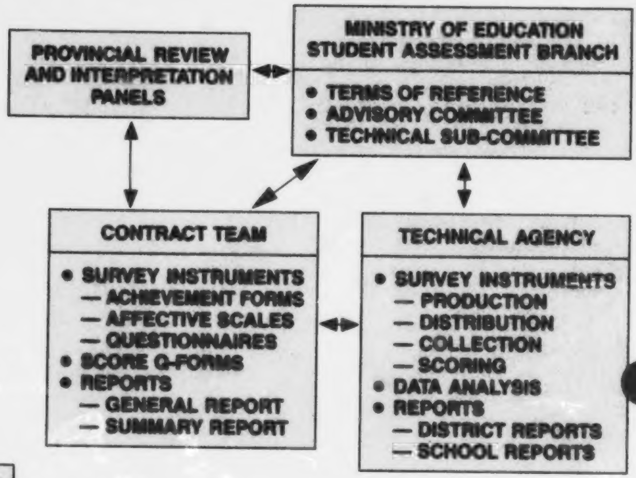
PURPOSE OF THE ASSESSMENT

The main principle underlying province-wide assessments is that the decisions about education should be based on up-to-date information on what and how students are learning.


CURRENT PERFORMANCE OF STUDENTS
ATTITUDES OF STUDENTS
JUDGMENTS ABOUT ADEQUACY OF 1985 PERFORMANCE
FUTURE DECISIONS AFFECTING MATHEMATICS INSTRUCTION IN BRITISH COLUMBIA
APPROPRIATENESS OF CURRENT CURRICULA AND MATERIALS
CHANGES IN PERFORMANCE
STUDENT AND TEACHER BACKGROUND INFORMATION

WHO CONDUCTED THE ASSESSMENT?

The Contract Team was headed by Dr. David Robitaille from the University of British Columbia. The Contract Team was guided by an Advisory Committee of teachers, one administrator, and Ministry representatives. The Educational Research Institute of British Columbia was responsible for the production, distribution and scoring of forms and the analysis of the results. The Contract Team scored the Q-Forms. The initial pool of achievement items and the questionnaires were assembled and constructed by the Contract Team during the summer of 1984. Piloting was done during the fall of 1984. Review panels of mathematics teachers assessed the appropriateness of the questions for the final forms. Interpretation panels met in July, 1985 to interpret the provincial results. Names of all participants can be found in the Summary Report.



STUDENT PERFORMANCE RATED BY INTERPRETATION PANELS

Interpretation Panels consisting of 15 members at each grade level rated student performance on the following five domains of the mathematics curriculum: Number and Operation, Geometry, Measurement, Algebraic topics, and Problem Solving. Performance was also rated on a number of objectives within each domain.

*MPC — the Mean Percent Correct is the average percentage of students who chose the correct response for items in a particular domain or objective.

**PR — Panel Rating:
ST — Strong
VS — Very Satisfactory
S — Satisfactory
M — Marginal
W — Weak

Because some objectives or domains provided a more difficult task, or because some items were more difficult than others, the panel ratings were not based solely on the mean percent correct, but rather on the "widely held expectations" for students on those items at that grade level.

	Grade 4		Grade 7		Grade 10	
DOMAIN/OBJECTIVE	MPC*	PR**	MPC	PR	MPC	PR
1. Number and Operation	66	S	63	S	58	M
Number Concepts and Computation	72	S-VS	70	S	48	M
Estimation	65	S	—	—	—	—
Fractions and Decimals	52	M	58	M	62	S
Ratio, Proportion and Percent	—	—	62	S	61	S
2. Geometry	63	S	53	M-S	47	M
Geometric Figures	68	S-VS	57	S	47	M
Geometric Relationships	58	S	50	M	46	M
3. Measurement	62	M-S	54	M	55	S
Metric Units	60	M	60	M	69	S
Perimeter, Area and Volume	59	S	44	M	50	S
Time and Temperature	68	S	—	—	—	—
4. Algebraic Topics	66	S-VS	52	S	52	M
Expressions, Equations and Inequalities	63	S	44	M	48	M
Graphs	69	VS	76	VS	60	S
5. Problem Solving	47	M	60	S	42	S

Q-FORMS

At each grade level, approximately 4% of the students completed an achievement form (Q-Form) which required students to give written responses to questions.

Grade 4: Students performed very well on items which asked them to create story problems for numerical expressions such as 28 + 84 and 84 × 28. Students did well on computations involving whole numbers, but had difficulty dividing $27.00 by 6. Results on the problem-solving items were encouraging.

Grade 7: Approximately 90% and 70% of students, respectively, were able to measure length to the nearest centimetre and millimetre. Approximately 50% of students were able to measure the size of an angle to the nearest degree, and 60% were able to draw an angle given its measure. Students demonstrated satisfactory levels of performance in computational skills, but had some difficulty with order of operation. The most commonly used strategies for problem solving were drawing a diagram and writing an equation.

Grade 10: Performance was generally good on items which focused on students' understanding of algebraic concepts and operations. Students had some difficulty with the concept of variable in expressions and functional relationships, where the variable may assume a number of values. Students performed satisfactorily on computational items and on routine story problems.

COMPARISON WITH PREVIOUS ASSESSMENTS

Grade 4 1977 — 1981 — 1985

Domain	No. of Items	1977	1981	1985
Number and Operation	12	71%	72%	74%
Measurement	10	57%	57%	58%

Grade 4 1981 — 1985

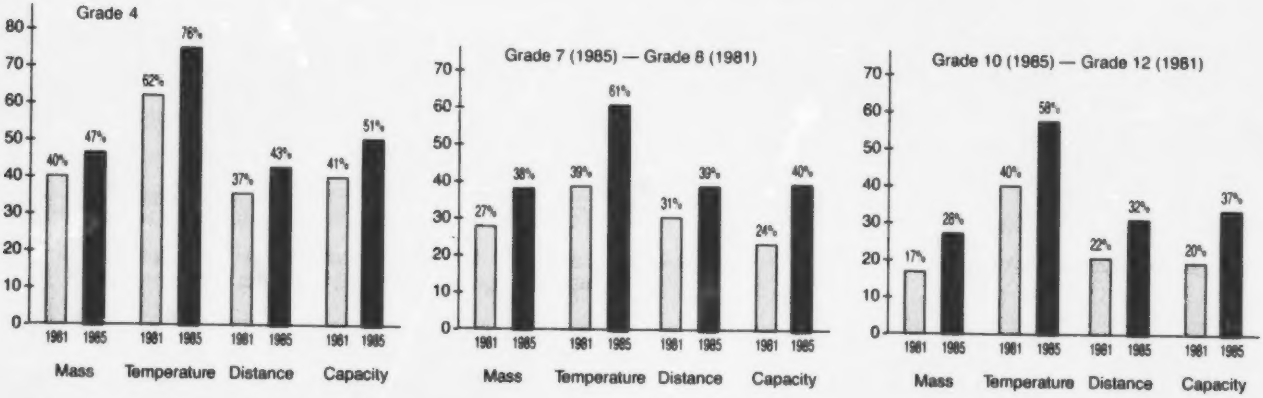
Domain	No. of Items	1981	1985
Number and Operation	21	69%	71%
Geometry	11	67%	67%
Measurement	19	60%	63%
Algebraic Topics	10	59%	64%

In previous assessments, Grades 4, 8, and 12 participated. A sample of Grade 8 students was tested in 1985, and a sample of Grade 10 students was tested in 1981 to allow for comparisons. There was some evidence that the sampling procedures may have resulted in biased samples so no cross-year comparisons were made at these levels.

METRIC USAGE

Students were given four items to determine the extent to which they used metric units when responding to statements about mass, temperature, distance, and capacity. Each item consisted of a question followed by two correct answers, one in metric units and one in imperial units. The following graphs show the percentages of students who expressed a preference for metric units.

Percentages of Students Expressing a Preference for Metric Units



As might be expected, students at the lower grade levels showed a stronger preference for metric units. The largest change since 1981 was on the temperature item, and this is the only item on which the majority of students at all grade levels expressed a preference for the metric unit. The responses for Grade 7 in 1985 are very similar to the responses for Grade 4 in 1981. This would indicate that usage of metric units does not change much as students mature.

STUDENT ATTITUDES

Students expressed their opinions on ten mathematics topics indicating whether or not the topics were important, easy to learn, and enjoyable to learn. The ten topics were not identical for the three grade levels. The percentages of students who gave positive responses are presented in the following table. The reported percentages are the averages over the ten topics.

	Percentage of Students Giving Positive Responses		
Grade	Important	Easy	Enjoyable
4	78	62	63
7	77	57	50
10	57	52	41

- Students rated those topics dealing with number and operations as most important. Geometric topics were rated as much less important, although Grade 4 students felt these topics were easy and enjoyable. Grade 4 and Grade 7 students rated learning the metric system as important but difficult and unenjoyable. This topic was not presented to Grade 10 students. Solving word problems was rated as moderately important, but Grade 7 and Grade 10 students rated it as difficult and unenjoyable.
- Students expressed fairly non-stereotyped views of mathematics with respect to gender. The majority of students disagreed with statements such as, "Men make better scientists and engineers than women."
- About 90% of students indicated that both parents thought that learning mathematics was important.
- About 80% of students said that they would like to learn more about computers, and most students expressed confidence in their ability to learn how to use computers. About 30% of students indicated that computers were present in the home.

MATHEMATICS TEACHERS

- The median years of teaching experience was 11-15 years at all three levels which represents a trend to an aging cohort of mathematics teachers. This trend is strongest at Grade 10 where 39% of teachers had more than 15 years of mathematics teaching experience.
- The typical Grade 4 teacher teaches mathematics every day for about 40 minutes, but many spend more time than that. There is some degree of specialization at Grade 7 with some teachers teaching more than one mathematics class. Approximately 50% of Grade 10 teachers teach mathematics almost exclusively, and 25% teach only one or two mathematics classes.
- Although teachers have a fairly good academic preparation, there has been an increase, since 1977, in the proportion of teachers who have taken no mathematics education courses.
- About 50% of Grades 4 and 7 teachers, and 56% of Grade 10 teachers, had attended a mathematics session at a conference within the last three years.
- Fewer than 5% of teachers in Grades 4 and 7, and 27% of Grade 10 teachers belonged to the B.C. Association of Mathematics Teachers.
- Student activities reported by teachers for their mathematics classes were surprisingly similar across grades. Students were engaged in seatwork about 40% of the time. About 60% of teachers reported no students working in small groups, and about 33% said that students worked in small groups up to one-quarter of class time. Stations and activity centres were used more in the lower grades, but even at Grade 4, they were used by fewer that 20% of the teachers.
- Teachers are of the opinion that more attention should be given to the teaching of problem solving in mathematics. They are also of the opinion that the resources available to them at the present time for this task are inadequate.
- The majority of Grade 4 teachers, 35% of Grade 7 teachers, and 15% of Grade 10 teachers did not allow students to use calculators in class.
- About half of the teachers at all levels believed it essential that computers become an instructional tool for teaching mathematics.

RECOMMENDATIONS

- That the Ministry of Education re-examine the goals and objectives of the Learning Assessment Program, and that the use of evaluation strategies designed to assess the cognitive processes utilized by students be considered for inclusion in all future assessments as was done in the Q-Forms in this assessment.

- That increased emphasis be given to the study of geometry at all grade levels, and that in-service programs in the teaching of geometry be made available to teachers.

- That teachers in all subject areas make a determined effort to use metric units exclusively in their teaching, and that conversion of units within the metric system be given increased emphasis.

- That, in the forthcoming revision of the mathematics curriculum, emphasis be given to appropriate uses of calculators and computers in the teaching of mathematics, and that a computer literacy program, separate from the mathematics curriculum, be developed and implemented for Grades K-12.

- That the Curriculum Revision Committee pay particular attention to the development of rational number concepts and of computational skills with rational numbers expressed either as common or as decimal fractions. In particular, it was recommended that decimal concepts and operations be introduced in the lower grades before the corresponding work with common fractions, in order that teachers may take advantage of students' knowledge of place-value concepts with whole numbers.

- That the development of skills and strategies which can be used to solve non-routine problems in mathematics be a major focus of the revised curriculum at all levels. It was also recommended that supplementary materials for the teaching of problem solving be made available to teachers for use with their students.

- That principals and school district personnel ensure that, regardless of grade level, only those teachers who have adequate preparation, both academic and professional, be permitted to teach mathematics. It was also recommended that all Faculties of Education in British Columbia include, as compulsory components in their teacher education programs for prospective elementary teachers, a course in mathematics and one in methods of teaching mathematics.

SECOND INTERNATIONAL MATHEMATICS STUDY

Twenty countries participated in the study which was conducted during the 1980-81 school year. Comparisons of student performance among countries require caution because of differences in curriculum. To facilitate interpretation of results, teachers were asked to indicate whether or not their students had the opportunity to learn the content tested by each question. Grade 8 results on five domains for eight jurisdictions are presented in the table below. Student achievement (ACH) is in percentage of questions answered correctly, and opportunity to learn (OTL) is the percentage of questions which teachers rated as appropriate for their curriculum.

Jurisdiction	Arithmetic		Algebra		Geometry		Measurement		Descriptive Statistics	
	ACH	OTL	ACH	OTL	ACH	OTL	ACH	OTL	ACH	OTL
Japan	60	85	60	83	58	51	69	95	60	83
British Columbia	58	87	48	85	42	51	52	78	55	86
France	58	86	55	86	38	43	60	92	42	71
Ontario	54	87	42	71	43	50	50	85	39	63
United States	51	84	42	69	38	44	45	45	42	69
England and Wales	48	79	40	63	45	54	49	49	48	85
New Zealand	46	67	39	63	45	59	46	59	40	63
Sweden	41	68	32	50	39	39	49	67	32	50

Overall, the Grade 8 results place British Columbia students among the top third of the 20 participating countries, and higher than students from any other English-speaking jurisdiction.

At the Grade 12 level, the British Columbia sample was drawn from all students enrolled in Algebra 12. Algebra 12 students represented 30% of the age cohort in British Columbia. In most jurisdictions, the population from which the sample was drawn represented less than 15% of the age cohort. Comparisons under these circumstances must be limited. The performance of students in British Columbia compared favourably with that of students in Ontario and the U.S.A. International comparisons among the top 1% and the top 5% of students in each country on content that is appropriate to the British Columbia curriculum showed that British Columbia students did as well as those in almost every other country. However, students in most of the other countries have been exposed to much more content and the content has been covered in much greater depth.

FOLLOW-UP

Provincial Level

Representatives of the Student Assessment Branch will meet with other branches to inform them of the data collected and of the recommendations directed at the Ministry of Education. The results and recommendations have been studied carefully by the committees working on the revisions to the British Columbia Mathematics Curriculum.

District Level

The Student Assessment Branch has provided each district with reports showing district and provincial results at each grade level.

Each district is encouraged to discuss district performance in light of these findings and to make recommendations to the Board of School Trustees.

School reports giving domain level results have been prepared for every school in the province that was involved in the assessment. Interpretation of the school level results is to be done under the direction of the superintendent or designate.

The assessment was conducted by a team under contract to the Student Assessment Branch. Members of the Contract Team were:

D. Robitaille (Chairman)	University of B.C.
T. O'Shea	Simon Fraser University
T. Rogers	University of B.C.
L. Dukowski	Langley S.D.
W. Klassen	Richmond S.D.
G. Phillips	New Westminster S.D.
A. Taylor	University of B.C.

Members of the Advisory Committee were:

C. Bognar	Educational Research Institute of B.C.
K. Carlson	Maple Ridge S.D.
H. Elwood	Burnaby S.D.
B. Mills	Curriculum Development Branch
J. Opra	Revelstoke S.D.
D. Robitaille	University of B.C.
S. Zonnis	Central Okanagan S.D.
A. Olson (Chairman)	Student Assessment Branch

The Summary Report of the 1985 Mathematics Assessment presents highlights of the survey, summary tables of important results, and the recommendations made by the Contract Team. This report was distributed to school district offices in sufficient quantities for one copy per school, to universities and colleges, and to other education institutions.

The General Report includes all results for achievement items, attitude scales, and questionnaires; in-depth discussion of issues; and the recommendations of the Contract Team. The distribution of this report is limited because of the technical nature of its content.

Additional copies of these reports, in limited numbers, are available from:

Student Assessment Branch
Ministry of Education
Parliament Buildings
Victoria, B.C.
V8V 2M4

(604) 387-4611

Province of British Columbia
Ministry of Education
Schools Department
Programs Division
Student Assessment Branch

Number/
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BRITISH COLUMBIA
MATHEMATICS ASSESSMENT
1985

General Report

A REPORT TO
THE MINISTRY OF EDUCATION
PROVINCE OF BRITISH COLUMBIA

QC
5735
D. B25 M29
1982

THE 1985 BRITISH COLUMBIA MATHEMATICS ASSESSMENT

GENERAL REPORT

edited by

David F. Robitaille
Thomas J. O'Shea

for the
Student Assessment Branch
Ministry of Education

The Mathematics Assessment Contract Team

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Wendy Klassen	Teacher Richmond School District
Garry Phillips	Vice-principal and teacher New Westminster S.D.
Alan R. Taylor	Research Assistant University of B.C.

October 1985

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THE 1985 B.C. MATHEMATICS ASSESSMENT

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Becky Mills	Curriculum Development Ministry of Education
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THE 1985 B.C. MATHEMATICS ASSESSMENT

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TABLE OF CONTENTS

PREFACE.. vii
1. INTRODUCTION.. 1
2. INSTRUMENTATION AND SAMPLING.. 9
3. GRADE 4 RESULTS.. 21
4. GRADE 7 RESULTS.. 59
5. GRADE 10 RESULTS.. 103
6. ALTERNATE TEST FORMS.. 155
7. TEACHERS OF MATHEMATICS.. 203
8. CONCLUSION AND RECOMMENDATIONS.. 235

APPENDICES

A. Contributors to the Report.. 241
B. Members of Review Panels.. 242
C. Members of Interpretation Panels.. 243
D. List of Pilot Schools.. 244
E. Grade 4 Data.. 245
F. Grade 7 Data.. 289
G. Grade 10 Data.. 337
H. Grade 4 Teacher Questionnaire.. 381
I. Grade 7 Teacher Questionnaire.. 389
J. Grade 10 Teacher Questionnaire.. 397
K. Alternate Test Forms.. 405

PREFACE

This *General Report* of the 1985 Mathematics Assessment contains a description of each of the major components of the study, an analysis of the major findings, and a set of recommendations directed at policy makers in the educational system of British Columbia. The goals of this year's Assessment were to monitor patterns of students' achievement in and attitudes toward mathematics, to assess the extent of changes in those patterns since the previous Assessment, and to conduct a brief survey of teachers and teaching practices in mathematics.

Not surprisingly, given the complexity of the project, we were not completely successful in our efforts to attain all of these goals. In particular, a problem with sampling of classes at the Grade 8 and Grade 10 levels arose and it was considered serious enough to cause us to abandon our efforts to document changes in student outcomes at those two grade levels. For that reason, change is discussed only at Grade 4 in this report.

On a more positive note, the inclusion of alternate assessment booklets consisting mainly of open-ended items proved to be a rich source of data on the mathematical processes used by students. Some initial results from these data are presented in Chapter 6, and more will be forthcoming in the near future.

We are indebted, as always, to the teachers of mathematics, the principals, and school district personnel throughout the province for their participation. In addition, special thanks are due to a small number of individuals whose assistance in the analysis of the Q-form data and in the preparation of this report was invaluable. This group includes Lorraine Baron, Catharine Farkas, Bonnie Isles, Sandy Luedtke, Teresa Robitaille, and Jane Smith.

Finally, we extend a special word of thanks to our colleagues on the Contract Team. Without them the task would have been impossible to accomplish. Thanks to their diligence and expertise, it has been a rewarding professional experience.

David F. Robitaille, U.B.C.
Thomas J. O'Shea, S.F.U.

CHAPTER 1

INTRODUCTION

David F. Robitaille

The third British Columbia Mathematics Assessment was conducted during the 1984-85 school year. In the latter part of May, students in Grades 4, 7, and 10 throughout the province, plus a probability sample of Grade 8 students, completed test booklets which included a background information scale, attitude inventories, and achievement items. At the same time teachers of mathematics at those grade levels completed questionnaires developed for the project. The Assessment was conducted under the auspices of the Student Assessment Branch of the Ministry of Education by a Contract Team composed of three university professors and three teachers of mathematics. Technical assistance and data processing were provided by the Educational Research Institute of British Columbia.

The first two British Columbia Mathematics Assessments (Robitaille & Sherrill, 1977; Robitaille, 1981) were carried out in 1976-77 and 1980-81. Both of those projects involved students from Grades 4, 8, and 12; and in 1981, a sample of Grade 10 students was included as well. The decision to include Grade 10 and exclude Grade 12 from the third Assessment was based on the re-introduction of provincial secondary school leaving examinations two years ago. The decision to change from testing at Grade 8 to Grade 7 had been contemplated for several years, and was first done in the 1984 Reading Assessment. Grade 7 is the last year of elementary schooling in B.C. and represents a major breakpoint in the provincial educational system. For that reason it seems appropriate to include Grade 7 in an assessment program such as this.

Organization of the Assessment

Several groups of people participated in the design and execution of the 1985 Mathematics Assessment. In addition to approximately 80 000 students and their teachers, these included the staff of the Student Assessment Branch of the Ministry of Education, the members of the Contract Team, personnel from the Educational Research Institute of British Columbia (ERIBC), as well as the members of the Advisory Committee, the Technical Sub-Committee, the Review Panels, the Interpretation Panels, and the teachers and students from those schools which assisted in pilot-testing the instruments.

The Contract Team had primary responsibility for designing the Assessment, developing the instruments to be utilized in the project, and writing the final reports. The team included two members of the Faculty of Education at the University of British Columbia, one member of the Faculty of Education at Simon Fraser University, two elementary school teachers from the New Westminster and Richmond School Districts, and a secondary school vice-principal from Langley.

As the technical agency for the Assessment, ERIBC was responsible for printing, distributing, and collecting the Assessment booklets and questionnaires; for selecting the Grade 8 sample; for scoring the responses and analyzing the data; and for providing consultative services to the Student Assessment Branch and the Contract Team on matters related to the technical, statistical, and psychometric aspects of the study.

The Technical Sub-Committee consisted of representatives from the Student Assessment Branch, the Contract Team, and ERIBC. The function of this committee was to provide a forum for the discussion of matters of a technical or statistical nature related to the assessment.

The Advisory Committee provided guidance and advice to the Contract Team and the Student Assessment Branch on the development of the instruments and on the interpretation of the findings. They also chaired the meetings of the Review Panels and Interpretation Panels. The members of the Advisory Committee were selected from across the province by the Student Assessment Branch to reflect a cross-section of opinion on matters related to the teaching and learning of mathematics. The committee included among its members three teachers and a principal as well as personnel from the Ministry of Education and the Chairman of the Contract Team.

The Review Panels and Interpretation Panels were made up of educators and informed members of the public selected from across the province. Their task was to discuss the objectives of this Assessment and to comment on the test items, attitude scales, and questionnaires developed for use in the study. The Interpretation Panels met after the Assessment data had been analyzed to examine the results and to comment on the students' performance.

Scope of the Assessment

The Learning Assessment Program is based on the premise that systematic collection and dissemination of comprehensive reliable data are essential components of the effective management of education in this province. Decisions about new directions or new emphases in educational matters should be based upon a clear understanding of what students are learning and how they are being taught.

The objectives of province-wide Assessments are as follows:

to inform professionals and the public of some of the strengths and weaknesses of the public school system;

to assist the Ministry, school districts, and schools in decisions related to the development, review, modification, revision, and implementation of curricula and supporting instructional resource materials;

to assist the Ministry in decisions concerning allocation of resources;

to identify areas of need and provide directions for change in both pre-service and in-service teacher education and professional development;

to provide directions for educational research;

to monitor student learning over time; and

to provide the province, school districts, and schools with information which can be used to maintain strengths and overcome identified weaknesses.

Within the framework of these general guidelines, the 1985 Mathematics Assessment was designed to address the following questions:

To what extent are students in Grades 4, 7, and 10 achieving the objectives of mathematics education as specified in the current curriculum guide?

What is the status of students' knowledge of certain topics, such as geometry, problem solving, and statistics, which are likely to play a more important role in the revised mathematics curriculum which is under development at the present time?

To what extent have levels of achievement changed from those reported in 1977 and 1981, and how do achievement levels in British Columbia compare to those in other jurisdictions?

How are achievement levels related to certain aspects of students' backgrounds, their attitudes and opinions, and those of their teachers?

> What are teachers' opinions and attitudes concerning a number of important issues about mathematics education?

Although a conscientious effort was made to obtain reliable data to address each of these questions, it has not been entirely possible to do so. In the case of changes in patterns of achievement since the 1977 and 1981 Assessments, for example, serious doubts about the representativeness of the Grade 10 sample in 1981 and the Grade 8 sample in 1985 were raised, and a decision was made not to include any discussion of the change data at these two grade levels. The sampling problem itself is discussed in some detail in Chapter 2.

A difficulty also arose in connection with two items at each grade level, which sought information about the highest level of education attained by parents. Although these items had been used with apparent success in other projects and in other jurisdictions to obtain information about socio-economic status, they did not appear to work properly in this Assessment. The results, particularly at Grade 4, conflicted with data available from other sources and, for that reason, no use has been made of them.

Student Outcomes

The major objective of every Learning Assessment is to evaluate students' performance in a particular discipline. For the 1985 Mathematics Assessment, seven broad areas of mathematics were selected for evaluation. These *domains* were:

Number and Operation
Geometry
Measurement
Algebraic Topics
Probability and Statistics[1]
Calculators and Computers
Problem Solving

The first four domains were each partitioned into two or three *objectives*, and test items corresponding to the domains and objectives were put together by the Contract Team during the summer of 1984. Most of the items selected were ones which had been used in previous Assessments here or elsewhere and which, therefore, did not need to be pilot-tested. Those which were developed for use in this project, less than 25% of the total, were pilot-tested in the Fall. Items were then selected to form a final pool of 450 items: 150 at each of the three grade levels. These were divided equally among three forms at each level, and, within each grade, each booklet contained the same number of items corresponding to each domain and objective.

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[1] At Grade 4 this domain involved Probability only.

The Probability and Statistics and Calculators and Computers domains represent areas of mathematics which are not, strictly speaking, part of the prescribed curriculum in British Columbia at this time. For example, although the current curriculum guide (Curriculum Development Branch, 1978) contains statements encouraging teachers to use calculators in appropriate situations, there are no curricular objectives which deal specifically with the use of calculators or computers. Similarly, the Curriculum Guide does not include Probability as a topic at the Grade 4, 7, or 10 level. These domains were included in the 1985 Assessment for the same reason that non-curricular objectives were included in the 1981 Assessment. These are important topics in mathematics, not only in school but in the real world, and they are likely to figure prominently in the new curriculum which is to be introduced shortly. The results obtained here will provide important baseline information on the knowledge of these areas which our students have acquired either in school or elsewhere.

Unlike the other domains, problem solving is an integral part of the curriculum although not usually as a topic of content. Instead, problem solving is usually considered to consist mainly of the study of the application of concepts and techniques to real-life situations, typically presented in "word problem" format. The problem-solving domain in this Assessment was intended to reflect the importance of problem solving in the mathematics curriculum and to evaluate students' ability to solve non-routine problems. The National Council of Teachers of Mathematics, in its *Agenda for Action* (1980), strongly encouraged teachers to pay more attention to the teaching of problem-solving skills and strategies, and to include problems of various types, presented in ways other than the traditional format. The first of the eight specific recommendations contained in the *Agenda for Action* states that, "Problem solving should be the focus of school mathematics in the 1980s."

A new feature included in this Assessment was a set of two booklets at each grade level which were made up of open-ended rather than multiple-choice items. They were administered to a 4% sample of students at each grade level. These so-called Q-forms provided an opportunity to investigate such issues as the comparison of performance levels on the same item presented in different formats, and the types of strategies used by students in solving problems. Similar but much more extensive work in this area has been done in the United Kingdom by the Assessment of Performance Unit (Foxman, Martini, Tuson, & Cresswell, 1980) and is currently under investigation by the Educational Testing Service in the United States for use in future national assessments in the U.S.

Each Assessment booklet, including the Q-forms, contained a set of background information items and one of three scales designed to elicit students' opinions and attitudes about their use of calculators and computers, their opinions about a number of topics in the mathematics curriculum, and their opinions about sex stereotyping in mathematics. Such scales are commonly used in evaluation projects of this kind, and they have been included in all three Mathematics Assessments. Students' opinions and attitudes are important outcomes of schooling and correlates of achievement; therefore, they should form an integral part of any major evaluation project.

The sex-stereotyping scale consisted of 15 items. Students were asked to indicate the extent of their agreement or disagreement with statements such as:

> Men make better scientists and engineers than women.
>
> A woman needs a career just as much as a man does.
>
> My father is usually able to help me with my mathematics homework if I ask him to help.
>
> My mother is usually able to help me with my mathematics homework if I ask her to help.

Inclusion of this scale resulted in a number of complaints being made to the Ministry of Education, articles in newspapers, and some discussion in the provincial legislature to the effect that presenting such items to students constituted an invasion of privacy and might engender the stereotyped behaviours delineated in some of the items. Moreover, students in a few school districts in the Lower Mainland were directed not to respond to the items on this scale. This reaction was fairly localized and had little impact on response rates provincially.

The sex-stereotyping scale was included in the Assessment to address an extremely important issue, and the items were drawn from studies conducted elsewhere, including the Second International Mathematics Study. Previous studies, in British Columbia as well as elsewhere, have shown that boys, beginning at about age 13, outperform girls in virtually every aspect of mathematics and that, at least in British Columbia, girls are much more likely than boys to drop out of mathematics as soon as they are able to do so. Thus, for example, 60% of Algebra 12 students are boys. Educators have been concerned about this question for some time and there is some evidence that the situation is improving; however, it remains an important issue for all concerned citizens. We need to find out why these differences exist. Some researchers have said that the cause is genetic (Stanley & Benbow, 1980): girls are not as good as boys at mathematics. Others have reported that socialization factors are the cause (Fennema and Sherman; 1977, 1978). Although these findings have been challenged, there remains a need to investigate other possible sources of explanation including the impact of societal and familial pressures.

Teacher Survey

Each teacher of mathematics at Grades 4, 7, and 10, along with the teachers of the classes in the Grade 8 sample, was asked to complete a Teacher Questionnaire prepared for the Assessment. These questionnaires were much briefer than the ones used in previous Mathematics Assessments, and dealt with fewer topics.

The questionnaires were divided into four major sections dealing with aspects of the teachers' background, their opinions about a number of topics included in the mathematics curriculum, their teaching of problem solving, and their opinions about the use of calculators and computers. Many of the items were identical to items in the students' booklets.

Summary

The 1985 Mathematics Assessment, like its two predecessors, was designed to produce a portrait of the state of mathematics education in the schools of the province. The major areas addressed in this report concern students' achievement levels, their attitudes and opinions about a number of topics of contemporary interest in the field, and the opinions and attitudes of the teachers of mathematics.

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CHAPTER 2

INSTRUMENTATION AND SAMPLING

W. Todd Rogers *Thomas O'Shea*

In the 1985 Mathematics Assessment information was collected about students' achievement in mathematics, their attitudes toward the subject, and selected aspects of their personal backgrounds. In addition, questionnaires were developed to obtain information from the teachers, and the procedures employed in their development are described in Chapter 7.

Two types of items were used to collect information about students' performance. As in the two previous Mathematics Assessments, multiple-choice items were used to determine levels of achievement. To gain insight into the approaches students used in a variety of mathematical situations and the thought processes they employed, a set of open-ended items was also developed at each grade level and administered to a sample of students. Described here are the procedures followed to construct the multiple-choice instruments. Included with this description is a discussion of the measurement of change between assessments. Chapter 6 contains a description of the development of the open-ended items and the sampling procedure used to select students.

Background Information

In keeping with previous Assessments conducted in British Columbia and in other places, students were asked to provide personal information about their age, gender, whether English was their first language, and the language commonly spoken at home. As a result, it was possible to analyze achievement and attitude performance in terms of variables which had been shown to influence performance in earlier assessments (Robitaille, 1981).

Students were also asked to respond to questions related to their current mathematics course, including amount of homework, and to their future plans for enrolling in different mathematics courses offered at Grades 11 and 12. Finally, to provide information about the extent to which students had adopted the metric system, they were asked to state which units, metric or British, they would use in four practical measurement situations.

Attitudes toward Mathematics

Justification for assessing attitudes comes not only from the tradition of learning assessments, but also from the importance attached to affective variables in research and in the assessment of outcomes and processes of schooling. Predictors are still being sought from the affective domain, as well as from among personalogical and process variables, to increase the accuracy of statistical models to explain and predict variation in mathematics achievement. Alternatively, affective measures are thought to reflect outcomes of schooling. In this sense, affective variables are outcomes to be explained or predicted rather than variables to be used to explain or predict.

Two of the attitude scales used in this Assessment were adapted from scales developed by the International Association for the Evaluation of Educational Achievement (IEA) for inclusion in the Second International Study of Mathematics. The first scale, *Mathematics in School*, consisted of a list of 10 mathematics topics or activities. Students were asked to indicate three things for each topic: how important they felt the topic was, how easy it was, and how much they liked learning the topic. The topics and activities included for each grade level reflected the mathematics curriculum at that level.

The second scale, *Gender and Mathematics*, comprised 15 items. Some of these items were designed to assess students' views about differences in mathematical ability between males and females. Others examined students' perceptions of their parents' attitudes toward, and ability to do, mathematics. This scale was used at all three grade levels.

The third set of attitudinal items, *Calculators and Computers*, was developed specifically for the 1985 Mathematics Assessment by the Contract Team. It consisted of two parts, each with 10 items. On the first set of items, students were asked to describe their use of calculators and computers. The second set assessed the students' perceptions about the efficacy and benefits of computers. The same 20 items were used at all three grade levels.

Although responses to the items were structured differently depending on the scale, with the exception of "use" items in *Calculators and Computers*, a common five-point Likert format was adopted. An example of an item taken from *Mathematics in School* and illustrative of the differences is shown in Figure 2-1.

1. Solving equations.

A.	not at all important	not important	undecided	important	very important
B.	very difficult	difficult	undecided	easy	very easy
C.	dislike a lot	dislike	undecided	like	like a lot

Figure 2-1. Sample attitude item, Mathematics in School.

The content validity of these scales was reported to be satisfactory by the Advisory Committee and the Review Panel for each grade level. Because the results were to be reported at the item level, and not for the scale, estimates of internal consistency were not considered to be appropriate and were, therefore, not computed.

Achievement Items

Construction of the achievement component of the Assessment instruments involved a number of sequential tasks: determining the domains and objectives at each grade level, generating assessment items, pilot testing, and selecting the final sets of items to be used in the assessment. The aim was not to evaluate individual courses, but to assess what students knew and were able to do in mathematics in relation to topics in the currently prescribed curriculum, and to a number of others which were likely to be included in future curricula.

All of the items used in the Assessment were presented in multiple-choice format with five response choices, including an "I don't know" option. Students recorded their responses on an optical-scoring sheet designed specifically for this Assessment.

Domains and Objectives

The content domains were determined by the Contract Team, with the assistance of the Advisory Committee. Within each domain, objectives were identified and, where possible, these objectives were standardized across grades. The domains, together with their objectives, are listed in Table 2-1.

Table 2-1
Domains and Objectives

Domain	Grade 4	Grade 7	Grade 10
1. Number & Operation	1.1 Number concepts & computation 1.2 Estimation 1.3 Fractions & decimals	1.1 Number concepts 1.2 Fractions & decimals 1.3 Ratio, proportion, & percent	1.1 Number concepts 1.2 Fractions & decimals 1.3 Ratio, proportion, & percent
2. Geometry	2.1 Geometric figures 2.2 Geometric relationships	2.1 Geometric figures 2.2 Geometric relationships	2.1 Geometric figures 2.2 Geometric relations
3. Measurement	3.1 Metric units 3.2 Perimeter, area, & volume 3.3 Time & temperature	3.1 Metric units 3.2 Perimeter, area, & volume	3.1 Metric units 3.2 Perimeter, area, & volume
4. Algebraic Topics	4.1 Expressions, equations, & inequalities 4.2 Graphs	4.1 Expressions, equations, & inequalities 4.2 Graphs	4.1 Expressions, equations, & inequalities 4.2 Graphs
5. Probability & Statistics	5.1 Probability	5.1 Probability 5.2 Statistics	5.1 Probability 5.2 Statistics
6. Calculators & Computers	6.1 Computer literacy 6.2 Calculator use	6.1 Computer literacy 6.2 Calculator use	6.1 Computer literacy 6.2 Calculator use
7. Problem Solving	7.1 Problem solving	7.1 Problem solving	7.1 Problem solving

The first four domains, and their associated objectives, are related to the prescribed mathematics curriculum in British Columbia. The next two domains, Probability and Statistics and Calculators and Computers, dealt with content which is not included in the present prescribed curriculum. These were included to measure students' performance on topics considered important by such groups as the National Council of Teachers of Mathematics and the National Council of Supervisors of Mathematics. Further, they reflect the increasing introduction, albeit informal, of these topics in present day schools, as well as the direction of the new curriculum. By including such topics now, base-line data will be available against which results of future assessments of a revised curriculum may be compared. The seventh domain, Problem Solving, comprises problems which cannot be solved by the direct application of a taught algorithm. As such, this domain is directly related to the prescribed curriculum; it concerns the thinking processes used in mathematics.

Generation of Items

In addition to selecting items from among those developed in British Columbia for use in previous Mathematics Assessments, items were drawn from existing sources such as the British Columbia Mathematics Test project (Robitaille, Sherrill, Kelleher, & Klassen, 1979), the National Assessment of Educational Progress in the United States, the Second International Study of Mathematics, surveys conducted by the Assessment of Performance Unit of the National Foundation for Educational Research in England and Wales, the New Zealand Item Bank, and assessments in other Canadian provinces such as Alberta and Manitoba and a few American states including California and Minnesota. Original items were also constructed by the Contract Team, particularly for those objectives for which previously used items were not available, such as on the topic of calculator use.

Items included in the pools reflected a wide range of difficulty so that students of varying levels of ability would be challenged. Other considerations also guided the formation of the item pools. Comparison of performance with the first and second Mathematics Assessments was required, and, although not a priority, cross-grade comparisons were to be possible.

Pilot Testing

All newly constructed items, as well as those selected from the sources listed earlier but modified either in the stem or options, were pilot tested to determine their psychometric properties. For the pilot study, two test forms, each containing 40 items, were assembled at each of the three grade levels. Pairs of forms contained some items in common and some unique items. The unique items were distributed between the two forms so that the forms were as parallel as possible in terms of content and estimated difficulty.

The pilot testing was completed during October, 1984. The sample for this testing consisted of six classes per form selected to represent large urban and rural areas. Since the actual Assessment was to be conducted toward the end of the school year, it was decided to conduct the pilot-testing in Grades 5, for Grade 4; 8, for Grade 7; and 11, for Grade 10.

Standard item statistics were computed for each option of each item. On the basis of these results, items which showed any of the following characteristics were either eliminated or modified prior to being considered for possible use in the Assessment:

- more than 95% or fewer than 10% of the students correctly answered the question;
- not all distractors attracted respondents;
- the biserial correlation between the correct answer and total test score was less than .20;
- the biserial correlation between the correct answer and total test score was less than the biserial correlation between a distractor and the total test score.

Final Selection of Items

A total of 150 achievement items, to be distributed across three forms at each grade level, were selected from the corresponding grade level item pool. For the final selection of items, the Contract Team first identified appropriate items from those pilot-tested and those drawn from previous Assessments. For each objective the number initially selected was somewhat greater than the number required. These items were then presented to the Advisory Committee who made recommendations as to which items should be retained for the Assessment.

The final selection was made by the Contract Team after reviewing the face validity of each item and the content validity of the group of items referenced to each objective and domain. The final number selected for each domain is shown in Table 2-2.

Table 2-2
Structure of 1985 Assessment

Domain/Objective	Grade 4		Grade 7		Grade 10	
	No.	%	No.	%	No.	%
1. Number & Operation	45	30	42	28	36	24
Obj. 1.1	24	16	15	10	9	6
Obj. 1.2	12	8	18	12	12	8
Obj. 1.3	9	6	9	6	15	10
2. Geometry	24	16	36	24	24	16
Obj. 2.1	12	8	18	12	9	6
Obj. 2.2	12	8	18	12	15	10
3. Measurement	27	18	15	10	21	14
Obj. 3.1	12	8	9	6	6	4
Obj. 3.2	9	6	6	4	15	10
Obj. 3.3	6	4	– [a]	–	– [a]	–
4. Algebraic Topics	18	12	24	16	30	20
Obj. 4.1	9	6	18	12	21	14
Obj. 4.2	9	6	6	4	9	6
5. Probability & Statistics	12	8	12	8	15	10
Obj. 5.1	12	8	6	4	6	4
Obj. 5.2	0	0	6	4	9	6
6. Calculators & Computers	12	8	12	8	15	10
Obj. 6.1	9	6	6	4	6	4
Obj. 6.2	3	2	6	4	9	6
7. Problem Solving	12	8	9	6	9	6

[a] The objective was not included at that grade level.

Additional consideration was paid to the selection of items for the measurement of change. The 1985 Assessment was the third Assessment of mathematics in British Columbia thereby permitting the measurement of change from 1977 to 1981 to 1985, and it was decided to include as many change items as possible in order to maximize the validity of any comparisons made on a given topic. The numbers of such items in each change domain are given in Table 2-3.

Table 2-3
Number of Change Items

	Domain	Grade 4	 7	 10
1.	Number & Operation	21	15	16
2.	Geometry	10	10	11
3.	Measurement	18	10	12
4.	Algebraic Topics	10	10	16
5.	Probability & Statistics	9	10	9

Construction of Test Forms

Prior to composing the final Assessment instruments, a review of the set of selected achievement items, attitude scales, and student background questions was conducted by a Review Panel at each grade level. Each Panel included five teachers of mathematics selected from throughout British Columbia, and was chaired by a member of the Advisory Committee. The membership of these panels is given in Appendix B.

Panel members were asked to review each achievement item for its appropriateness to the curriculum, its relationship to the objective to which it was referenced, its readability and clarity, and the fairness of its distractors. Attitude scales and student background questions were evaluated for readability, clarity, offensiveness, and invasion of privacy. Minor modifications were made as a result of this review.

Test Forms

Given the large number of achievement items and the need to complete the Assessment within a regular classroom period of approximately 45 minutes, three forms were used at each grade level. This provided for adequate curriculum coverage and the opportunity to measure change. The three forms were constructed to be parallel in terms of content coverage and estimated difficulty.

The first items assigned to each form were the change items. These were distributed in such a way as to avoid the inclusion of similar items on the same form. The remaining achievement items were then assigned so that altogether each form contained 50 items. First, items were organized by objective within each form, with two to four items per page. The forms were then constructed, with the first page containing items from Objective 1.1, while the remaining pages were randomly ordered. The final forms were generally balanced with respect to difficulty, with equal numbers of items referenced to each objective. A summary of item assignments by objective-form is presented in Appendices E, F, and G.

The three attitude scales were distributed one to each form. These were placed first in the booklets, followed by the student background information and achievement items.

An informal timing pilot was conducted in December 1984 to ensure that the 45-minute time limit was reasonable. The final forms were administered to three classes at the corresponding grade levels. Teachers were asked for information regarding the amount of time required and the clarity of the administration instructions.

Measurement of Change

The terms of reference for the 1985 Assessment called for the measurement of change at Grades 4, 8, and 10. At Grade 4, population data were available from the 1977, 1981, and 1985 Assessments. At Grade 8, population data were available for 1977 and 1981; a sample was selected for 1985 to yield a sample of approximately 100 classes. At Grade 10, population data were available for 1985, and sample data for 1981.

Both the 1981 Grade 10 and the 1985 Grade 8 samples were designed to yield a random sample of 104 classes, approximately 2500 students, thus permitting the construction of valid confidence intervals to assess the significance of observed differences. Both samples were selected according to a two-stage stratified design, subject to the restriction that only one class be chosen from each sample school. At Stage 1, schools were listed in decreasing order of enrollment within six geographical zones. The number of schools to be selected from each zone was determined in proportion to enrollment. To allow for non-response, a total of 120 schools was allocated at this point. Substrata were then formed within each zone such that each substratum was allocated two of the number of schools allocated to that zone. Sample schools were then selected with probability proportional to size.

At Stage 2, one class was selected from each sample school. In 1981, for Grade 10, principals were instructed to "...assign a number to each Grade 10 Mathematics, English or homeroom class. Place these numbers in a hat and draw one number for each class to be tested." In 1985, for Grade 8, principals were directed as follows: "If you have more than one classroom of Grade 8's, the Assessment should be administered to the class which has its Mathematics class first in the week (or cycle) at your school."

Comparison of the results at Grade 10 for the 1981 sample with the results for the Grade 10 population in 1985 on common items seemed to indicate that there had been a significant drop in achievement. At the Grade 8 level, the opposite result was observed. This apparent contradiction led to a special study to see if the methods of sampling Grade 10 classes in 1981 and Grade 8 classes in 1985 had contributed to an artificial inflation of scores in the two samples.

This special study was conducted by ERIBC. Employing the 1985 Grade 10 population data, it was possible to draw 1985 samples according to both the 1981 instructions and the 1985 instructions. The absence of bias brought about by sampling problems would be revealed by nonsignificant differences between the results for each of the samples drawn and the results for the population from which the samples were selected. However, the results, in summary form, were as follows:

a) strict adherence to the 1981 principals' instructions yielded a sample of 1985 classes, the results from which were not different from the results for the entire population in 1985;

b) 1981 results were significantly higher than the corresponding 1985 results obtained in (a), with the differences varying from 2% to 7% on each objective;

c) selection of classes according to 1985 instructions led to domain results which were comparable to the 1981 results and significantly higher than the corresponding results obtained in (a).

Thus, it would appear that the actual sampling employed in 1981 and 1985 brought into serious question the validity of the proposed change analysis. It was not possible to conduct meaningful and valid change analysis with confidence at the Grade 8 and Grade 10 levels. The sampling problem did not occur at the Grade 4 level where the total population was assessed in each Assessment. Therefore, change results are reported in this volume for Grade 4 only.

Several hypotheses can be raised as explanations of the faulty sampling results. It may be that principals, when developing school schedules, timetable their academic classes first so that these classes occur more frequently in first positions. The definition of a mathematics class may be unclear, with some principals including only "regular" mathematics classes, excluding alternative or modified classes. And, it must be acknowledged, some principals, uncertain about the use to which the Assessment results are to be put, might have purposely selected classes which would perform more favourably. To overcome these potential problems in future Assessments, it is recommended that the instructions used for sampling in 1981 be clarified and used, and that the selection of classes be made centrally as part of the technical agency contract.

Participation Rates

The participation rates for each grade level are reported in Table 2-4 for Grades 4, 7, and 10 respectively. Included in the counts are the number of students who responded to the Q-forms--1082 at Grade 4, 1074 at Grade 7, and 817 at Grade 10.

Table 2-4
Participation Rates

Grade	Enrollment (February 1985)	Participants (May 85)	Participation Rate
4	35 413	33 409	94%
7	35 890	33 888	94%
10	39 947	29 661	74%

The non-participation rates at Grades 4 and 7 are within the normal daily absentee range of 4 to 7% for the province. At Grade 10, the lower participation rate reflects a higher absentee rate, 9 to 10%, and it may also indicate that some schools did not administer the Assessment instruments to all students enrolled in Grade 10.

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20
Instrumentation and Sampling

CHAPTER 3

GRADE 4 RESULTS

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The results of the 1985 Mathematics Assessment for Grade 4 are summarized in this chapter. A discussion of these results by domain and objective is preceded by descriptions of the instruments, the student population, and their attitudes toward mathematics. Relationships between achievement patterns and certain attributes of students, as well as changes in achievement since the 1977 and 1981 Assessments, are discussed in the latter part of the chapter. Specific items of interest have been used to illustrate Assessment objectives but, because of space limitations, it was not possible to discuss every one. All percents reported in the chapter have been rounded to the nearest whole number.

The Grade 4 Interpretation Panel rated the results obtained on each item, objective, and domain using five rating categories:

Strong	ST
Very Satisfactory	VS
Satisfactory	S
Marginal	M
Weak	W

The ratings given by the Panel were based on their personal and professional opinions on the acceptability of the results, and should not be considered absolute. In rating performance, panelists were asked to bear in mind the following factors: the total population of students in British Columbia and the wide range of individual differences at this level, the importance of the skill, and the curricular validity and difficulty of each item. The Panel's ratings of the scores, and pertinent comments on each domain and objective are reported in this chapter. Also recorded are the ratings for each item.

Description of the Instruments

Three Assessment booklets, labelled R, S, and T and each containing 50 achievement items, were used at the Grade 4 level. This pool of items was designed to assess students' mastery of seven domains: Number and Operation, Geometry, Measurement, Algebraic Topics, Probability and Statistics, Computers and Calculators, and Problem Solving. The domains were subdivided into 14 objectives, as shown in Table 3-1.

In addition to these three booklets, two alternate test forms, Q-1 and Q-2, comprising open-ended items were administered to a four percent sample of the Grade 4 population. The Grade 4 Q-1 form evaluated two aspects of problem solving: the ability of students to write an appropriate story for a given operation on two numbers and the ability of students to select an appropriate operation on two numbers for a given story. The Q-2 form focussed on actual problem solving. Detailed discussion of the Q-forms is contained in Chapter 6.

The number of items included in the item pool for a given objective or domain was determined on the basis of the relative importance of that objective or domain at the Grade 4 level. As is shown in Table 3-1, 30% of the Grade 4 items fell into the Number and Operation domain, while the two non-curricular domains accounted for 8% each.

All achievement items were in a multiple-choice format, and students marked their responses on answer sheets specially designed for the Assessment. Each item had five response choices, four of which were possible answers, while the fifth was "I don't know." The 150 items were partitioned among the three booklets so that each booklet contained an equal number of items for each of the 14 objectives, and no item appeared in more than one booklet.

Development of Items

During the summer of 1984 about 400 items were either written specifically for this Assessment by the Contract Team or were drawn from a number of sources. Some were chosen from those made public by the National Assessment of Educational Progress in the United States, and others from the British Columbia Mathematics Achievement Test Project, from previous Assessments and existing item banks, and from the Minnesota Educational Computing Consortium computer literacy questionnaire.

All newly-developed items were field tested and reviewed in the Fall of 1984. One hundred fifty items were subsequently chosen.

In addition to the content items, each booklet contained 16 background items which provided information on students' age, gender, first language, homework, and familiarity with SI metric units; and one of three sets of attitude items: Scale R, *Mathematics in School*; Scale S, *Gender and Mathematics*; and Scale T, *Calculators and Computers*.

Table 3-1
Grade 4: Organization of Test Items

Domain / Objective	Number of items	Percent
1. **Number and Operation**	45	30
Number Concepts and Computation	24	16
Estimation	12	8
Fractions and Decimals	9	6
2. **Geometry**	24	16
Geometric Figures	12	8
Geometric Relationships	12	8
3. **Measurement**	27	18
Metric Units	12	8
Perimeter, Area and Volume	9	6
Time and Temperature	6	4
4. **Algebraic Topics**	18	12
Expressions, Equations and Inequalities	9	6
Graphs	9	6
5. **Probability** [a]	12	8
6. **Computers and Calculators** [a]	12	8
Computer Literacy [a]	9	6
Calculator Use [a]	3	2
7. **Problem Solving**	12	8
Total	150	100

[a] Non-curricular objective.

Description of the Population

In May 1985 when the Assessment was administered, Grade 4 students who had been age 6 at the time of their enrollment in school were either 9 or 10 years old. Approximately 90% fell into this category, and five percent were older. The number of respondents was equally divided between boys and girls.

Responses to the items regarding language reveal that while 10% of the students did not learn English as a first language, only 6% usually speak a language other than English at home.

Metric Usage

Each booklet contained four items to measure the degree to which students use metric units in situations dealing with mass, temperature, distance, and capacity. Each item was accompanied by two correct responses: one in SI metric units and the other in British units. Students were directed to choose the answer which came to mind first. Results for both the 1981 and 1985 Assessments at all three grade levels are summarized in Table 3-2. The 1981 and 1985 Assessments evaluated different grade levels and this makes comparisons problematic.

The results show that while students' metric usage has increased slightly over the four years since the last Assessment, most students continue to use British units in most measurement situations. The item dealing with temperature is the only one on which a large majority of Grade 4 students selected the metric units. The data across all three grades show that students' metric usage is greater in the lower grades, and this is consistent with the 1981 results.

Mathematics in School

Form R of the Assessment booklets contained a scale entitled *Mathematics in School*, which consisted of a list of 10 topics from the elementary mathematics curriculum up to and including Grade 4. For each topic, students were directed to respond on a five-point scale to three questions according to their perception of the importance of the topic (from "not at all important" to "very important"), the easiness of the topic (from "very difficult" to "very easy"), and their enjoyment of the topic (from "dislike a lot" to "like a lot"). For reporting purposes, the two positive responses were combined, as were the two negative ones, to produce a three-point scale. Positive response rates are summarized in Table 3-3.

Students appear to believe that all of these topics are important. The ones rated most important were adding, subtracting, multiplying and dividing whole numbers; learning about fractions; and checking answers by going back over them. The least important, but easiest topic, was learning about squares, rectangles, and triangles. Students also felt that checking answers by going back over them was easy. This is in contrast to teachers who reported that this topic was relatively difficult to teach. Seventy-seven percent of the students thought this topic was easy, whereas only 37% of teachers found it easy to teach. Less than half the students felt that learning about decimals and learning about the metric system were easy. Students at this age appear to enjoy all topics to a similar extent. These results ranged from 52%

who enjoyed learning about decimals, to 77% who enjoyed adding, subtracting, multiplying and dividing whole numbers.

Table 3-2
Responses to Metric Usage Items
(Percent)

	1981 Gr.4	1985 Gr.4	1981 Gr.8	1985 Gr.7	1981 Gr.12	1985 Gr.10
How much does a bicycle weigh?						
About 15 kilograms	40	47	26	38	16	28
About 35 pounds	59	53	72	62	82	72
What is the temperature in this room?						
About 20 degrees	61	76	38	61	40	58
About 70 degrees	38	24	60	39	59	42
How far is is from Prince George to Prince Rupert?						
About 700 kilometres	37	43	30	39	22	32
About 450 miles	63	57	67	61	77	68
How much gasoline can the gas tank in a large car hold?						
About 90 litres	41	51	23	40	19	37
About 20 gallons	59	49	74	60	79	63

The majority of students at this age apparently feel that most mathematics topics are important, moderately easy, and enjoyable. Geometry was rated as important by the smallest margin, but still by a majority. Students appear to like most topics, and did not indicate a dislike of the others. It is interesting to note that while learning about squares, rectangles and triangles was the easiest and a very enjoyable topic, it was rated least important.

Table 3-3
Grade 4: Mathematics in School
(Percent)

Topic	Important	Easy	Like
Adding, subtracting, multiplying and dividing whole numbers	93	63	77
Learning about decimals	73	46	52
Learning about fractions	87	64	72
Learning the metric system	81	45	56
Learning how to estimate	69	58	61
Learning about squares, rectangles, and triangles	55	89	72
Checking answers by going back over them	90	77	53
Using graphs	76	64	68
Solving word problems	73	63	64
Learning about place value	81	55	57

Gender Stereotyping

The attitude scale in Form S dealt with the topic of *Gender and Mathematics*. It contained 15 items with responses which ranged on a five-point scale from "Strongly Agree" to "Strongly Disagree." The purpose of these items was to determine the degree of sex stereotyping that exists among students with respect to mathematics. Results show that, for the most part, students do not display strong stereotyped attitudes. For example, 65% of Grade 4 students disagreed with the statement that, "Boys need to know more mathematics than girls," while only 18% agreed.

Five of the 15 items dealt with boys' and girls' mathematical ability and career choices. The remaining items concerned parents' enjoyment of mathematics, the degree of interest and ability parents display in the students' mathematics homework, and the degree of importance parents place on mathematics in their children's education.

Approximately half the students thought that their fathers enjoyed doing mathematics. The results were similar for mothers. A large percentage of the students, 80%, indicated that their father or mother is usually able to help them with mathematics homework; and an even higher percentage, 93%, agreed that both their mothers and fathers believed it was important to learn mathematics. Ninety-three percent agreed that their parents wanted them to do well in mathematics.

The results of two items on the scale dealing with natural ability are more difficult to interpret. One item stated that "Girls have more natural ability in mathematics than boys," and 57% of students disagreed while 23% agreed with that opinion.

Boys and girls responded in quite different ways to this item. While 68% of boys disagreed with the item, only 45% of the girls did. Similar results were found for the statement, "Girls can do better than boys in mathematics." Fifty-eight percent of students disagreed: 66% of boys, and 50% of girls. Disagreement with these items may not indicate that students feel that boys have greater natural ability in mathematics than girls, or that they can do better than girls in mathematics. They may suggest rather, that respondents believe the mathematical ability of each sex is equal. In fact, for items that favoured boys, girls reacted with stronger negative responses. Each sex answered in a more defensive manner when the item favoured the opposite sex.

Calculators and Computers

Students responding to Form T of the Assessment booklets completed twenty items designed to gain information about their use of calculators and computers. While items differ somewhat from those given in 1977 and 1981, indirect comparisons are possible.

Calculators

About half of the students, 53%, indicated that they own calculators. Almost all of the students, 91%, never use calculators in school. Ninety-seven percent of the students indicated that they were not permitted to use calculators on tests, and 79% said they were not allowed to use them at all to do mathematics. However, 11% said they could use calculators to check answers. In 1981, 96% of the Grade 4s said they did not use calculators in school, 61% did not use a calculator at home, and 86% did not use calculators to do homework. This indicates that calculator use outside of school is increasing among students of this age. There has been little change, however, in the use of calculators in the classroom at this grade level.

As might be expected, the rate of calculator ownership and use increases at the higher grade levels. For example, while 91% of Grade 4 and 72% of Grade 7 students stated that they never use calculators in school, this was true for only 25% of Grade 10 students. Similar but less dramatic results were found regarding calculator use outside of school.

The *Calculators and Computers* scale contained two items which asked students their opinions about the appropriateness of using calculators in school. The first item stated: "Some people say that Grade 4 students should NOT be allowed to use calculators in school. How do you feel about this?" Thirty percent of Grade 4 students disagreed with this statement while over half (54%) agreed. Similar results were reported by teachers with responses of 35% and 40%, respectively. The second item stated: "Some people say that if students are allowed to use calculators, then it should NOT be necessary for them to learn how to add, subtract, multiply, or divide by hand. How do you feel about this?" Fifty-one percent of the students disagreed with this statement and 38% agreed. A firmer position was taken on this question by teachers where 82% disagreed and only 13% agreed.

Computer Use

The T-Forms included 13 items dealing with computers: three sought information about computer use; and ten, about students' attitudes toward computers. Results show that about 30% of Grade 4 students have computers at home, about the same proportion as in Grade 7 and Grade 10. Only 13% of students said that they had never used a computer; and, of the 87% who had used one, the two most common uses were playing games (46%), and some form of computer-assisted instruction (24%).

Results from the 10 attitude items indicate that students have strong positive attitudes about the use of computers, are confident about their ability to make use of this technology, and would like to learn more about using computers. They are ambivalent about whether or not computers are gaining too much control over people's lives.

Domain 1: Number and Operation

This domain contained the largest number of items because of its importance in the curriculum at this age level. The 45 items were divided among three objectives: Number Concepts and Computation, Estimation, and Fractions and Decimals. By the end of Grade 4, students are expected to be able to perform the four basic operations with whole numbers, and to understand basic concepts of place value, fractions, and decimals. The items in the Number and Operation domain were intended to measure students' mastery of these skills and understandings. A summary of performance levels and of the Interpretation Panel's ratings is presented in Table 3-4.

Student performance on this domain was rated as Satisfactory. In the opinion of the Panel the major concepts included in this domain are being taught and learned satisfactorily.

Table 3-4
Grade 4: Number and Operation

Objective	Number of Items	Mean Percent Correct	Panel Rating
Number Concepts and Computation	24	72	S to VS
Estimation	12	65	S
Fractions and Decimals	9	52	M
Total	45	66	S

Number Concepts and Computation

Twenty-four items were used to measure students' mastery of this objective. The items dealt with the whole number concepts of place value and counting, and the four basic operations with whole numbers. Word problems with single and multi-step solutions were also included.

The overall rating for students' performance in this objective ranged between Satisfactory and Very Satisfactory, Table 3-5 contains a summary of the ratings given. It indicates that students' performance on most items dealing with whole number concepts and computation ranged from Marginal to Very Satisfactory. Performance on two of the items was rated as Strong while none was rated Weak.

Table 3-5
Interpretation Panel Ratings
Grade 4: Number Concepts and Computation

Rating	Item	Number of Items
Strong	R/1, S/3	2
Very Satisfactory	R/28, S/1, S/2, S/4, S/13, T/1, T/3	7
Satisfactory	R/3, R/29, S/24, S/25, T/2, T/31, T/47, T/48	8
Marginal	R/2, R/27, R/34, R/35, S/12, T/29, T/30	7
Weak	--	0

Performance on the following item, involving concepts that students are expected to understand, was rated Strong. Much time is spent on place value concepts in the primary grades, and it is gratifying to see such a high success rate on this item:

S/3 300 + 40 + 5 is the same as

	% of students
A. 345 *	96
B. 354	2
C. 435	1
D. 543	1
E. I don't know.	1

The following is an example of an item on which performance was rated Marginal. Students should be familiar with this application of the associative property of multiplication but, apparently, they are not. More than 25% chose "I don't know."

T/30 7 x 60 = 7 x (__ x 10)

	% of students
A. 4	5
B. 6 *	46
C. 8	8
D. 10	13
E. I don't know.	26

Few areas of particular difficulty or strength are apparent in student performance on this objective. Performance on items involving place value and regrouping concepts and skills varied from Marginal to Very Satisfactory. Three of the seven items on which performance was rated Marginal involved multiplication, and that may indicate a need for increased attention to be given to multiplication; including basic facts, factoring, and use of the commutative, associative, and distributive principles.

Estimation

Eight items were used to measure students' mastery of estimation. These involved estimating the sum, difference, or product of whole numbers. The skill of estimation is difficult to test because it is not possible to control the methods children use to answer a given item. For example, in the following item, students may have performed the addition first and then rounded the sum, thereby showing their knowledge of approximation instead of estimation:

R/23 79 + 53 is about

		% of students
A.	120	8
B.	130 *	77
C.	140	6
D.	150	4
E.	I don't know	3

The mean percent correct for this objective was 63, and this was rated Satisfactory. Although estimation seems to be adequately covered, continued emphasis is needed. Table 3-6 contains a summary of the ratings given to the estimation items.

Table 3-6
Interpretation Panel Ratings
Grade 4: Estimation

Rating	Items	Number of Items
Strong	--	0
Very Satisfactory	R/21, S/30, T/15	3
Satisfactory	R/22, R/23, S/26, S/29, T/16, T/44	6
Marginal	R/36, S/31, T/17	3
Weak	--	0

Two of the three items on which performance was rated as Marginal, explicitly involved subtraction, while the third item was a missing addend question which could be solved by subtraction:

R36 3900 + ______ = 6000

Which one of the following is CLOSEST to the number that goes in the box?

	% of students
A. 1000	5
B. 2000 *	43
C. 3000	25
D. 5000	12
E. I don't know	10

The content of the three items on which performance was Marginal suggests that the operation of subtraction and the concept of missing addends were factors adversely affecting student performance in estimation. The Interpretation Panel suggested that more emphasis be given to the concept of missing addends. Estimation should be given greater emphasis in the classroom because it is an important life skill.

Fractions and Decimals

The current curriculum guide for mathematics states that, by the end of Grade 4, students should be able to identify unit fractions of objects and sets, recognize and explain like fractions, add like fractions, write decimal numerals to 100ths, and add decimal fractions using money. The new items in this objective addressed those topics.

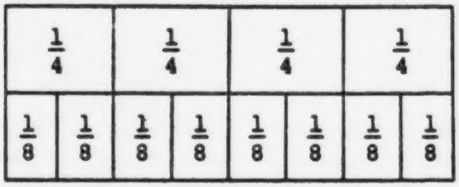
The mean percent correct for this objective was 52, and this level of performance was rated as Marginal. Table 3-7 contains a summary of the ratings given.

Table 3-7
Interpretation Panel Ratings
Grade 4: Fractions and Decimals

Rating	Items	Number of Items
Strong	--	0
Very Satisfactory	R/4, S/43	2
Satisfactory	S/35	1
Marginal	R/17, S/42, T/41, T/46	4
Weak	R/18, T/45	2

Paper-and-pencil tests may not be the best means for assessing students' knowledge of fraction concepts at this age level; classroom work with fractions usually involves the use of manipulative materials. Only one-third of students responded correctly to the following item dealing with equivalent fractions, even though it was accompanied by a diagram. These are difficult concepts and there is some evidence that they are too abstract for children of this age. Perhaps abstract, symbolic work with fractions should be postponed until a later grade level.

R/18 How many eighths are equal to 3/4?



		% of students
A.	2	17
B.	4	14
C.	6 *	33
D.	8	11
E.	I don't know	24

Domain 2: Geometry

Geometry objectives in the current curriculum guide for the primary grades deal mainly with the construction of geometric models and the manipulation of concrete materials. Because it is impossible to test these objectives in a paper and pencil format, the Assessment focussed on the prerequisites for these concepts and skills. Students at this level are also expected to identify and list properties of common 2-dimensional and 3-dimensional figures, extend their geometric vocabulary, and perform experiments involving translations, reflections, rotations, and flips. The 24 geometry items were divided between two objectives: Geometric Figures and Geometric Relationships.

The mean percent correct for all items was 63 and performance was rated Satisfactory. Table 3-8 displays the number of items in each objective with the mean percent correct and the Interpretation Panel's rating.

Table 3-8
Grade 4: Geometry

Objective	Total Number of Items	Mean Percent Correct	Panel Rating
Geometric Figures	12	68	S to VS
Geometric Relationships	12	58	S
Total	24	63	S

Geometric Figures

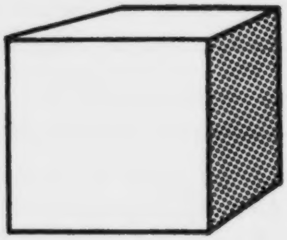
Twelve items were chosen to measure students' mastery of geometric figures. They included items dealing with terminology, the identification of 2-dimensional and 3-dimensional geometric figures, and items requiring spatial visualization. The mean percent correct for this objective was 68 and the overall performance was rated as Satisfactory to Very Satisfactory. Table 3-9 contains a summary of the ratings given.

Table 3-9
Interpretation Panel Ratings
Grade 4: Geometric Figures

Rating	Items	Number of Items
Strong	R/38, T/4, T/5	3
Very Satisfactory	R/5, R/39, S/45	3
Satisfactory	R/37, S/36, S/37, S/44, T/42	5
Marginal	T/43	1
Weak	--	0

Eight of the twelve items were accompanied by diagrams and this likely increased performance levels. An example of an item for which performance was rated Very Satisfactory required students to employ spatial visualization skills:

R/5 One face is shaded on this cube. How many faces does the cube have?



		% of students
A.	3	17
B.	6 *	76
C.	8	3
D.	12	1
E.	I don't know	2

The only item on which results were rated as Marginal was the vocabulary item shown below:

T/43 Which one of the following objects is most like a geometric plane?

		% of students
A.	a table top *	27
B.	a water glass	7
C.	an ice cream cone	20
D.	a shoe box	13
E.	I don't know	28

For this item, 28% of the students chose the "I don't know" response, suggesting a lack of familiarity with the term "geometric plane."

Geometric Relationships

Twelve items were used to measure students' mastery of geometric relationships. Items involved rotations, flips, and translations, and knowledge of terms such as "intersection," "symmetry," and "congruence." The mean percent correct for items in this objective was 58, and the overall performance was rated Satisfactory.

Most of the objectives in the current curriculum guide dealing with geometry in the primary grades suggest action, such as tracing, folding and constructing. This was taken into account by the Interpretation Panel when performance on the items in this objective was rated. Table 3-10 contains a summary of the ratings given.

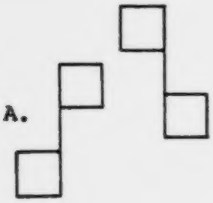
Table 3-10
Interpretation Panel Ratings
Grade 4: Geometric Relationships

Rating	Items	Number of Items
Strong	--	0
Very Satisfactory	R/40, S/38, S/39	3
Satisfactory	R/30, R/31, R/41, S/10, S/11, T/36, T/39, T/40	8
Marginal	T/35	1
Weak	--	0

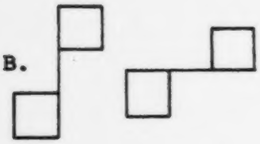
The following item is an example from this objective.

R/31 In which one of the following pairs is the figure on the right a slide image of the figure on the left?

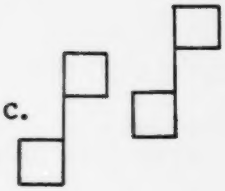
A.



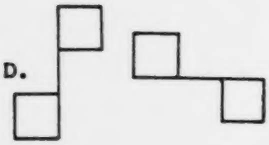
B.



C.



D.



E. I don't know.

Although less than half of the students responded correctly to this item, performance was still rated as Satisfactory. Had students been asked to actually perform the slide, results might have been better. Performance on only one item, dealing with symmetry, was rated Marginal.

Instruction in Geometry should be given a high priority, and it should be taught using practical applications. Since many geometric concepts relate to everyday life, the focus should be experiential with less emphasis on terminology. Results for this objective may indicate either not enough attention is being paid to geometry, or students are unable to transfer their experiences to paper and pencil questions. It is necessary to review the place of geometric topics in the curriculum and to determine at what stage the transfer from hands-on to abstract activities should occur.

Domain 3: Measurement

The 18 items in the Measurement domain were divided among three objectives: Metric Units; Perimeter, Area and Volume; and Time and Temperature. Table 3-11 summarizes the results. The mean percent correct for all items was 62 and the overall performance was rated between Marginal and Satisfactory.

Table 3-11
Grade 4: Measurement

Objective	Number Of Items	Mean Percent Correct	Panel Rating
Metric Units	12	60	M
Perimeter, Area and Volume	9	59	S
Time and Temperature	6	68	S
Total	27	62	M to S

Metric Units

The 12 items covering metric units measured students' knowledge of length, mass, and capacity. Panel ratings are found in Table 3-12.

Table 3-12
Interpretation Panel Ratings
Grade 4: Metric Units

Rating	Items	Number of Items
Strong	--	0
Very Satisfactory	S/16	1
Satisfactory	R/42, S/15, S/46, T/6, T/7, T/23	6
Marginal	R/9, R/10, S/14	3
Weak	R/6, T/8	2

Four of the twelve items dealt with conversion of units, six with estimating and choosing appropriate units, one with reading scales, and one with solving a multi-step problem involving length. Of the four items dealing with conversion, the performance on one was rated Weak, two were rated Marginal and one was rated Satisfactory. This indicates an obvious weakness in converting units. The Panel felt that these skills are basic and should be stressed at this grade level. An example of an item involving conversion follows:

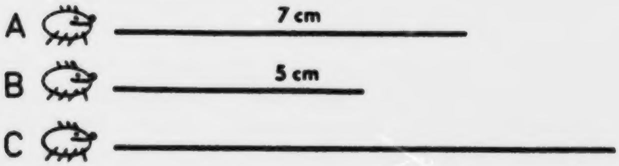
R/10. How many centimetres are in one metre?

		% of students
A.	1	2
B.	10	8
C.	100 *	76
D.	1000	10
E.	I don't know	5

Although three-fourths of the students responded correctly, the Panel felt that this was a basic and necessary concept, and rated the level of performance Marginal.

The one item on which performance was rated Strong involved more reading than the others and required a two step solution. It is shown below.

S/16 Three insects travelled along the ground. Insect C travelled twice as far as insect B. How much farther did insect C travel than insect A?



		% of students
A.	10 cm	18
B.	5 cm	11
C.	12 cm	7
D.	3 cm *	59
E.	I don't know	5

Except for one item, the percent of correct responses for items dealing with estimating and choosing appropriate units ranged from 67 to 80. Performance on those items were all rated Satisfactory.

Overall results on this objective were disappointing and thus were rated as Marginal by the Panel. Concrete materials and manipulations are essential to develop understanding of measurement concepts and to ensure subsequent improvement in this area. Through meaningful tasks at this age, students can begin to realize the relationships within and the ease of use of the metric system.

Perimeter, Area and Volume

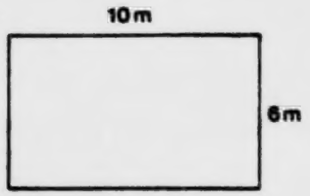
By the end of Grade 4, it is expected that most students are able to calculate the perimeter and area of a rectangle and to determine volume using cubic units. Of the nine items dealing with these topics, four dealt with perimeter, three with area and two with volume. The Panel ratings are found in Table 3-13.

Table 3-13
Interpretation Panel Ratings
Grade 4: Perimeter, Area and Volume

Rating	Items	Number of Items
Strong	T/10	1
Very Satisfactory	S/17	1
Satisfactory	R/11, R/32, S/18, S/22, T/24	5
Marginal	R/33	1
Weak	T/9	1

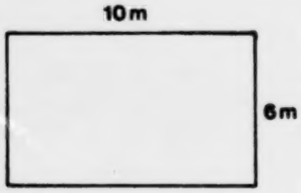
The Panel rated performance on this objective Satisfactory and the mean percent correct was 59. The most interesting observation regarded the responses to three similar questions, which used different formats to test perimeter.

R/11 What is the DISTANCE ALL THE WAY AROUND this rectangle?



		% of students
A.	16 m	15
B.	32 m *	67
C.	36 m	5
D.	60 m	9
E.	I don't know	4

S/18 What is the PERIMETER of this rectangle?



		% of students
A.	16 m	28
B.	32 m *	45
C.	36 m	4
D.	60 m	13
E.	I don't know	9

T/9 Mr. Jones put a wire fence all the way around his rectangular garden. The garden is 10 m long and 6 m wide. How many metres of fencing did he use?

		% of students
A.	16 m	48
B.	32 m *	19
C.	36 m	5
D.	60 m	22
E.	I don't know	6

Performance was rated Satisfactory on the first two items despite major differences between correct response rates. Panelists felt the second item was more difficult because of the use of the word "perimeter". Results were disappointing on the third item. It was more difficult than the others because it was wordier and lacked a diagram. This result suggests that students may be reluctant to read a problem through and to draw a diagram to help in the solution.

Performance on most of the area and volume items was assessed Satisfactory or better. The rating on one item was Marginal, three Satisfactory, and one Very Satisfactory.

Time and Temperature

Six items were used to measure students' mastery of this objective. Students were asked to respond to items dealing with topics such as reading a clock, computing time intervals, recognizing time relationships from days to weeks, reading a Celsius thermometer, and estimating temperature. The mean percent correct for this objective was 68 and overall performance was rated as Satisfactory. Table 3-14 contains a summary of the ratings given.

Table 3-14
Interpretation Panel Ratings
Grade 4: Time and Temperature

Rating	Items	Number of Items
Strong	T/12	1
Very Satisfactory	R/49, S/23	2
Satisfactory	S/47	1
Marginal	R/48	1
Weak	T/11	1

Students were able to perform the following tasks very well: read a Celsius thermometer, read a clock, and convert days into weeks. They were less able to compute time intervals and estimate temperature. Response to the following item suggest that there may be some confusion between our base-ten numeration system and conventional time intervals. One-fifth of the students chose 75 which would be the correct response if the item were interpreted as a 3-digit subtraction. Performance on the item was rated Marginal.

R/48 Teresa and Jerry played Bingo from 4:25 p.m. until 5:00 p.m. For how many minutes did they play Bingo?

	% of students
A. 95	8
B. 25	9
C. 35 *	47
D. 75	21
E. I don't know	5

Domain 4: Algebraic Topics

The 18 items in this domain were divided between two objectives: Expressions, Equations and Inequalities; and Graphs. The mean percent correct for the 18 items was 66 and overall performance was rated Satisfactory. Table 3-15 presents the total number of items in each objective with the mean percent correct and the Interpretation Panel's rating.

Table 3-15
Grade 4: Algebraic Topics

Objective	Number of Items	Mean Percent Correct	Panel Rating
Expressions, Equations and Inequalities	9	63	S
Graphs	9	69	VS
Total	18	66	S to VS

Expressions, Equations and Inequalities

The nine items in this objective dealt with definitions and symbols in algebra, the use of variables in equations and inequalities, and the use of variables to represent numbers. The mean percent correct for this objective was 63 and performance was rated Satisfactory. Table 3-16 contains a summary of the ratings given.

Table 3-16
Interpretation Panel Ratings
Grade 4: Expressions, Equations and Inequalities

Rating	Items	Number of Items
Strong	--	0
Very Satisfactory	S/7, S/8	2
Satisfactory	R/25, R/50, T/20, T/37	4
Marginal	R/24, S/9, T/21	3
Weak	--	0

Although the actual percentages of correct responses are not as high as in some other areas, the Panel rated performance as Satisfactory because this was a difficult area requiring higher level thinking skills.

Performance on the following item was rated Marginal. As previously mentioned in the Number and Operation domain, more work should be done with missing addend questions such as this. Only 45% of the students responded correctly to the item.

T/21 To find the missing number in
346 + ___ = 931 you should

		% of students
A.	subtract 346 from 931 *	45
B.	add 346 to 931	11
C.	subtract 931 from 346	22
D.	add 931 to 346	5
E.	I don't know	17

Graphs

Nine items were used to measure students' mastery of this objective. They involved the reading and interpretation of bar graphs, line graphs, and pictographs. The mean percent correct was 69 and performance was rated from Satisfactory to Very Satisfactory. Table 3-17 contains a summary of the ratings given.

Table 3-17
Interpretation Panel Ratings
Grade 4: Graphs

Rating	Items	Number of Items
Strong	R/7	1
Very Satisfactory	R/8, R/19, S/27, T/27	4
Satisfactory	S/28, S/48, T/25	3
Marginal	T/28	1
Weak	--	0

Much work is done across subject areas in the primary grades in graphing, and, as expected, students generally did well. The item on which performance was Strong required students simply to read a graph. On those items requiring more than the simple reading of graphs, results were Satisfactory to Very Satisfactory. The item on which performance was rated Marginal covered a non-curricular topic: reading and interpreting a pie graph.

Domain 5: Probability

Probability was one of four non-curricular topics included in the Assessment. The main purposes for its inclusion were to provide information on a topic which many people feel is important and should be part of the curriculum, and to measure change in performance on this topic since 1981. Results on this domain may assist the Ministry of Education and school districts in decisions related to the revision of existing curricula for this level.

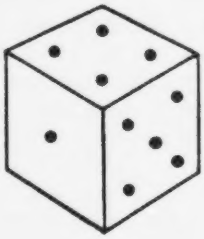
Twelve items were used to measure students' ability to judge the outcomes of situations involving basic concepts of probability. The mean percent correct for this domain was 55. Due to the difficulty levels of the items, the Panel's expectations were not as high as with other topics. Consequently, student performance was rated Satisfactory. Table 3-18 contains a summary of the ratings given.

Table 3-18
Interpretation Panel Ratings
Grade 4: Probability

Rating	Items	Number of Items
Strong	--	0
Very Satisfactory	R/15, S/33, T/13	3
Satisfactory	R/16, R/26, S/32, S/34, T/38	5
Marginal	R/20, T/14, T/22	3
Weak	S/49	1

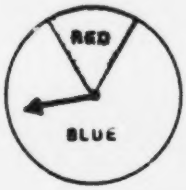
An example of a probability item on which performance was rated Very Satisfactory, R/15, is shown below, as well as an item on which performance was rated Weak: S/49. The item was accompanied by a diagram and it was assumed that most children of this age would have had some experience with spinners. The difficulty may have been due to the amount of reading.

R/15 If you tossed one die, what number would show up?



		% of students
A.	1, 2, or 3	3
B.	6	3
C.	an even number	7
D.	any number from 1 to 6 *	80
E.	I don't know	7

S/49 Sam and Sara are playing a game with this spinner. Every time the spinner lands on red, Sara gets a point. Every time the spinner lands on blue, Sam gets a point. After 10 spins, the winner will be the one with the most points. Who is more likely to win?



		% of students
A.	Sara will	7
B.	Sam will	39
C.	It will be a tie. *	6
D.	Either one has the same chance of winning.	35
E.	I don't know	6

Domain 6: Computers and Calculators

The integration of computers and calculators into the curriculum has occurred unevenly across the province. Although the use of these devices is not an integral part of the currently prescribed curriculum, information on student familiarity with and access to these instruments is considered important. Results from this domain will provide direction to decision-makers for purposes of planning the revised curriculum, allocating resources, and establishing needs for in-service work.

The twelve items in this domain were divided into two objectives: Computer Literacy and Calculator Use. Table 3-19 displays the total number of items in each objective with the mean percent correct and the Interpretation Panel's rating.

Table 3-19
Grade 4: Computers and Calculators

Objective	Number Of Items	Mean Percent Correct	Panel Rating
Computer Literacy	9	50	S
Calculator Use	3	63	S
Total	12	53	S

The mean percent correct for this domain was 53 and the overall performance was rated as Satisfactory.

Computer Literacy

The nine items in this domain dealt with the capabilities and applications of contemporary computers. Four of these items involved simple programming concepts. The mean percent correct was 50 and performance was rated as Satisfactory. Table 3-20 summarizes the ratings given.

The only item on which performance was rated Weak used an asterisk for multiplication, a symbol which only those familiar with certain computer languages would recognize. One-fourth of the students chose the distractor "the sum of the numbers" and one-third chose "I don't know." The Weak rating assessed in this case may not reflect students' abilities but rather their inexperience with computers.

Table 3-20
Interpretation Panel Ratings
Grade 4: Computer Literacy

Rating	Items	Number of Items
Strong	S/20	1
Very Satisfactory	R/45	1
Satisfactory	R/43, R/44, T/18, T/19, T/32	5
Marginal	S/21	1
Weak	S/19	1

The Panel assigned an overall performance rating of Satisfactory, taking into account the diversity of software and hardware in schools across the province. Results for this objective may not provide an accurate picture of the level of computer literacy within the province. They would be more meaningful at the district level where performance can be more closely related to accessibility and experience.

Calculator Use

Only three items were used to measure students' mastery of this objective. Similar to the computer objective, performance may have reflected experience more than ability. The mean percent correct was 63 and performance was rated as Satisfactory. Table 3-21 contains a summary of the ratings given.

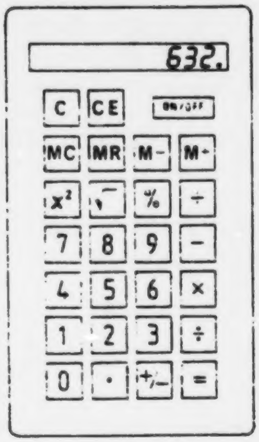
Table 3-21
Interpretation Panel Ratings
Grade 4: Calculator Use

Rating	Items	Number of Items
Strong	--	0
Very Satisfactory	--	0
Satisfactory	S/5, T/33	2
Marginal	R/46	1
Weak	--	0

Less than one-half of the students responded correctly to the following item on which performance was rated as Marginal.

R/46

The three digits in the display have just been entered. Now the $\boxed{7}$ key is pressed. What number will appear in the display?



A. 637.

B. 639.

C. 6327.

D. 7632.

E. I don't know.

While 46% of the students chose the correct response, the remaining responses were divided evenly among other distractors. This suggests a guess by most of these students, perhaps due to lack of experience with calculators.

A Satisfactory performance overall was given for this objective, taking into account the availability and use of calculators in schools. It is recommended that class sets of calculators be made available to all elementary grade levels for the following reasons: to teach their use, to use as teaching devices and to use in problem solving.

Domain 7: Problem Solving

Items in this domain were used to measure students' performance on and approach to non-routine problems, even though problem solving skills were considered an integral component of the entire Assessment. The items in this domain were designed with specific problem-solving strategies in mind. These strategies included making a list, guessing and testing, identifying operations needed, looking for patterns, and identifying insufficient and extraneous information. The intent of the 12 items in this objective was to assess the logic and processes students use to solve problems. The following is an example of one item on which performance was rated Marginal.

R/14 Joel had $3.50. He bought 6 apples for 25¢ each. How much money did Joel have left after buying the apples?

To solve the problem given above, which one of the following pairs of operations must you use?

	% of students
A. multiplication and subtraction *	44
B. addition and division	14
C. multiplication and division	10
D. division and subtraction	19
E. I don't know.	12

The overall performance for this domain was rated Marginal. Table 3-22 contains a summary of the ratings given.

Table 3-22
Interpretation Panel Results
Grade 4: Problem Solving

Rating	Items	Number of Items
Strong	--	0
Very Satisfactory	T/34	1
Satisfactory	R/13, R/47, S/6, T/49	4
Marginal	R/12, R/14, S/40, S/41, S/50, T/26, T/50	7
Weak	--	0

Although problem solving is an area of great importance, it was not surprising that the performance was low. The current curriculum and supportive materials do not emphasize the skills necessary for effective problem solving. Instead, routine story problems are the focus. The low performance was reflected by a mean percent correct for the 12 items in this domain of only 47.

Performance on only one question was rated above satisfactory. This item, as shown below, required students to identify missing information, a strategy perhaps linked more closely to solving a traditional word problem than other problem solving strategies.

T/34 Jason bought 3 boxes of pencils. What else do you need to know in order to find how many pencils he bought?

		% of students
A.	How much each box cost	11
B.	How much money Jason had	5
C.	How many pencils were in each box *	71
D.	How much change Jason received	3
E.	I don't know	6

Problem solving should be the focus of school mathematics in the 1980s. This position is supported by the National Council of Teachers of Mathematics and documented in its publication entitled *An Agenda for Action*. In taking this position, the Council identified a need for students to be able to deal with the personal, professional,and daily experiences of life which require the selection and use of problem solving skills in unexpected and unplanned settings.

The skills referred to by the Council include far more than just the ability to solve routine story problems. For example, students should be able to formulate key questions; analyze and conceptualize problems; define the problem and the goal; discover patterns and similarities; seek out appropriate data; experiment; transfer skills and strategies to new situations; and draw on background knowledge to apply to mathematics.

To achieve these objectives children need to be taught to read the whole question prior to answering it and to identify and utilize relevant information. Teachers should make manipulatives available and use them to teach problem solving in the classroom. They should stress the process of solving a problem rather than merely finding the answer. It should be noted that many activities can be done orally.

In addition, pre-service and in-service training for the teachers in the area of problem solving should be made a priority. The importance of this area must be stressed and educators should recognize that skills and attitudes developed through problem solving are beneficial in all areas of mathematics.

Changes in Achievement: 1977-1981-1985

One of the major objectives of the 1985 Mathematics Assessment at the Grade 4 level was to describe change in students' achievement over time. For this purpose, a total of 22 items, common to both the 1977 and 1981 Assessments, were distributed over two change categories: Number and Operation, and Measurement. An additional 49 items from the 1981 Assessment were also used to measure change in student performance. Comparisons between 1981 and 1985 are reported for five Change Categories: Number and Operation, Geometry, Measurement, Algebraic Topics, and Probability. The mean percent correct for each change category and percent changes across the three Assessments will be presented in this section along with an analysis of change.

Change Categories: 1977-1981-1985

Table 3-23 presents the number of items, mean percent correct and percent change for the two change categories that spanned the three Assessments. The Number and Operation change category consisted of 12 items and the Measurement change category consisted of 10 items.

Table 3-23
Grade 4: Change Categories: 1977-1981-1985
(Percent)

Change Category	Number of Items	Mean Correct 1977	Mean Correct 1981	Mean Correct 1985	1977 1981	1977 1985	1981 1985
Number & Operation	12	71	72	74	+1	+3	+2
Measurement	10	57	57	58	0	+1	+1

The data show that the 1985 results in both categories are slightly higher than the 1981 and 1977 results. In the Number and Operation category, performance in 1985 improved on eight of the twelve items compared to 1977 results, and on six items compared to 1981 results. There is no apparent pattern to the items on which performance improved in 1985. The largest increase, 21 percentage points, occurred between 1977 and 1985 on an item requiring students to identify a picture of a fraction of a whole. Two of the greatest increases noted were on word problems; however, three of the four items on which performance decreased were also word problems. It is interesting to note that results on all items on which performance dropped compared to 1977 or 1981, were still rated Satisfactory or better in 1985.

The overall change in the Measurement category is slightly positive. Students performed better in 1985 than on both previous Assessments on items relating to unit conversion and estimating temperature. However, performances in 1985 on the two items involving conversion of units were rated Marginal and Satisfactory, and a Weak rating was given to the performance on the item involving estimating temperature. Thus, despite the slight increase in performance, there is still room for improvement in these areas. Topics in which a decrease in performance was noted in 1985 compared to 1977 and 1981 were length, area, time intervals, reading time and reading a thermometer. As in 1977 and 1981, Panelists were disappointed with the results on the metric usage items.

Change Categories: 1981-1985

Table 3-24 presents the number of items, the mean percent correct, and the percent change for all five Change Categories from 1981 to 1985.

Table 3-24
Grade 4: Change Categories: 1981-1985
(Percent)

Change Category	Number of Items	Mean Correct 1981	Mean Correct 1985	1981-1985
Number and Operation	21	69	71	+ 2
Geometry	11	67	67	0
Measurement	19	60	63	+ 3
Algebraic Topics	10	59	64	+ 5
Probability	9	55	56	+ 1

Results show that performance is slightly higher in 1985 than in 1981 for all but the Geometry change category. The greatest change occurs in the Algebraic Topics domain where the mean percent correct increased by 5 points. Performance on three items within that domain increased by more than 10 percentage points. Two of these three items dealt with inequalities and the third with a missing sign in an equation.

In 1981, one of the recommendations was for teachers to spend more time on inequalities and missing addend questions. Improvement in the results of the three noted items may indicate that the recommendation was followed. However, concern remains in this area considering the ratings of performance in 1985. Performance on the two change items involving inequalities was rated as Satisfactory and Marginal in 1985. The improvement noted in this area may indicate a step in the right direction.

Reporting Categories

Although a student's achievement in mathematics is the result of a great many factors, some have been chosen for particular examination in past Assessments. In a report of this length it is not possible to explore the relationship among all factors of interest to mathematics educators, nor is it possible to report on even a very few in great depth. In the section that follows, student achievement in relation to gender and first language are discussed briefly. There is no attempt to imply a cause and effect relationship among these variables; the Assessment was not designed for that purpose.

Sex Differences

Based on overall student performance on items used in the Assessment, no significant differences were shown between boys and girls at this age level. The greatest difference in mean percent correct at the domain level is 3, where boys' performance in Measurement was higher than girls'. The mean percent correct for boys was also higher by 1 percentage point in the Computers and Calculators domain. Girls, on the other hand, scored a higher mean percent correct by 1 percentage point on each of the Number and Operation, Algebraic Topics and Problem Solving domains. Results were identical by gender for the Geometry and Probability domains, as well as on the test as a whole. Differences in performance by sex in the 1981 Mathematics Assessment were also small but tended to favour boys. Based on 1985 results, however, boys and girls at this age perform at similar levels of achievement on those areas which were tested.

First Language

One of the background items asked students whether they first learned to speak English, French, or another language. A comparison of performances between those who first learned to speak English and those in the other two categories shows the former group with somewhat higher scores on average. The differences on specific domain scores were small, with the greatest, a difference of 7 percentage points, in the Probability domain. Since many items in this domain contained long stems, it is possible that students who first spoke a language other than English were at a disadvantage because of the wordiness of the items. One would expect this discrepancy to diminish as these students grow older.

A difference of 4 points occurred in the Computers and Calculators domain, another non-curricular topic. All other differences were 3 percentage points or less. These differences were considered minor and overall results indicate that students with a non-English-speaking background do about as well as those students with an English-speaking background.

Summary

The Grade 4 Assessment instruments consisted of three test booklets, each containing 50 achievement items grouped into 14 objectives from seven domains. Eleven of the objectives assessed content currently prescribed in the B.C. Mathematics Curriculum. The remaining three dealt with content which is not presently prescribed, but, which is under consideration for possible inclusion in the future. Twenty-two items from the 1977 Assessment and 70 from the 1981 Assessment were repeated to examine changes in student achievement over time. In addition to the three standard test booklets, two alternate test forms composed of open-ended items were administered to a 4% sample of the Grade 4 population. Results from these two forms are discussed in Chapter 6.

In addition to content items, each booklet contained 16 background questions and one of three scales: *Mathematics in School, Gender and Mathematics*, or *Calculators and Computers*. The background items were common to each test form. All items were in multiple-choice format and students responded on a separate answer sheet. Every content item had five response choices of which four were possible answers while the last option was "I don't know".

Background Information

Approximately 90% of the students were either 9 or 10 years of age at the time of testing. About 50% of the respondents were boys and 50% girls. Responses to the items regarding language reveal that while 10% of the students did not learn English as a first language, only 6% usually speak some language other than English at home.

Test Results

In the Number and Operation domain, student performance was rated Satisfactory. Expectations were high in this domain and, for the most part, students were able to meet them. However, the Interpretation Panel concluded that much of the work done with common fractions, particularly as represented on a paper and pencil test, is too difficult for this age. It was suggested that more emphasis be placed on decimal fractions with particular application to the metric system.

As a whole, performance in the Geometry domain was rated as Satisfactory. The Panel believed that geometry should be given a higher priority and it should be taught using practical applications. It was suggested that the vocabulary in the current curriculum is extensive and should be replaced with more meaningful, "hands-on," transformational geometry.

Results from the Measurement domain received a Marginal to Satisfactory rating. Student performance on perimeter, area, volume, time, and temperature was rated as Satisfactory. There is a need for manipulative materials and real-life experiences in order to promote better understanding in this domain. Achievement dealing with metric units was disappointing. Results indicated that most students are not able to convert from one metric unit to another, a skill related to place value concepts.

Overall performance on the Algebraic Topics domain was rated Satisfactory to Very Satisfactory. Due to the high-level thinking skills needed to deal with expressions, equations and inequalities, expectations were not as high as in other domains. This was reflected by a high performance rating despite lower correct response rates. The concepts of missing addends and inverse operations continue to cause difficulty, despite an improvement shown from 1977 and 1981. Graphing appears to be a strength as results were rated Very Satisfactory.

Probability was one of the two non-curricular domains and performance was rated Satisfactory in light of students' inexperience with these types of questions and the difficulty level of the items. This is an area that could lend itself easily to classroom experiences but not necessarily for testing purposes.

The Computer and Calculator domain was also a non-curricular area. Performance in this domain was rated Satisfactory but was difficult to interpret due to the diversity of software and hardware, and the variations in availability of computer programs within schools throughout the province. It was suggested that district level interpretations would be more meaningful since they can be more closely related to accessibility and experience.

Overall performance in the Problem Solving domain was rated Marginal. Panelists were concerned that this must become a focal area. Students need to be exposed to a variety of problems and problem solving methods and teachers must analyze their own methods of presenting problems. In-service training in this area is essential.

Attitude Scales

The results of the *Mathematics in School* scale indicate that Grade 4 students consider all mathematics topics important. Performing basic operations with whole numbers, learning about fractions and checking answers by going back over there are the most important topics. The least important, but easiest topic, is learning about squares, rectangles and triangles. Learning about decimals and learning about the metric system are the most difficult topics. Students at this age appear to enjoy all topics.

Results from the *Calculators and Computers* scale indicate that about half of the students at this age own calculators. Half the students never use calculators outside school, and only one tenth ever use them in school. In fact, 97% of the students are not allowed to use calculators on tests, and 79% are not allowed to use them at all to do mathematics. Grade 4 students tend to be conservative in their opinions about the appropriateness of using calculators in school. Over half the students agreed that Grade 4 students should not be allowed to use calculators in school and about 40% thought that if they were allowed to, then it should NOT be necessary for them to learn the basic operations. These views may reflect inexperience with calculators.

Approximately 30% of students have computers at home, and only 13% of the Grade 4 students claim never to have used one. Almost half the students have played games on computers, and about 6% have written stories or letters. About half have used the computer to learn about mathematics or other subjects.

Results from the *Gender Stereotyping* scale reveal that while stereotypical attitudes regarding ability and career choices are not strongly apparent, there appears to be a greater tendency toward those kinds of attitudes at the younger grades than at the other two grade levels. Thirty-one percent of Grade 4 students agreed that men make better scientists than women, and almost 20% agreed that boys need to know more mathematics than girls.

Changes in Achievement: 1977 - 1981 - 1985

Two categories were used to measure changes in performance from 1977 to 1981 and 1985. These were Number and Operation, and Measurement. Five categories were used to measure change from 1981 to 1985: Number and Operation, Geometry, Measurement, Algebraic Topics, and Probability. The data show that 1985 results in all categories are slightly higher than those for either 1977 or 1981. The greatest increase, 5 percentage points, occurred on the Algebraic Topics domain between 1981 and 1985.

Sex Differences

The greatest difference between girls and boys in mean percent correct at the domain level was 3% where boys' performance in Measurement was higher than girls'. Boys also scored higher by one percentage point in the Computers and Calculators domain. Girls, on the other hand, scored higher by one percentage point on each of the Number and Operation, Algebraic Topics, and Problem Solving domains. Results were identical for the Geometry and Probability domains.

First Language

A comparison of performances between those students who first learned to speak English and those who first learned to speak French or another language showed that the former group had somewhat higher scores. The differences on specific domains were small with the greatest, a difference of 7 percentage points, occurring in Probability, a non-curricular topic. Other differences were minor and overall results indicate that students with a non-English-speaking background do about as well as those with an English-speaking background.

CHAPTER 4

GRADE 7 RESULTS

Garry W. Phillips *Thomas O'Shea*

This chapter contains a summary of the results of the 1985 Assessment for Grade 7. The first two sections in the chapter describe the instruments used and the population surveyed. This is followed by the survey data on attitudes and mathematical background, including the following scales: *Metric Usage*, *Mathematics in the School*, *Calculators and Computers*, and *Gender Stereotyping*. Next a discussion of the achievement results is presented by domain and objective, and specific items are used to illustrate each objective. Finally, performance by reporting categories, and an overall summary complete the chapter. All percents reported in this chapter have been rounded to the nearest whole number.

The Grade 7 Interpretation Panel rated the Assessment results for each item, objective, and domain using five rating categories:

Strong	ST
Very Satisfactory	VS
Satisfactory	S
Marginal	M
Weak	W

The ratings determined by the Panel were based on their personal and professional opinions on the acceptability of the results, and should not be considered as absolute. The ratings and pertinent comments of the Panel for each domain and objective are contained in this chapter.

This was the third Mathematics Assessment in British Columbia. To carry out the Assessment, about 500 items were developed over the summer of 1984. These items were drawn from a variety of sources such as the Third National Assessment of Educational Progress in the United States, the Manitoba Mathematics Achievement Program, the California Survey of Basic Skills, the New Zealand Item Bank, and the British Columbia Learning Assessment Item Bank. Some additional items were developed specifically for the 1985 Assessment during the summer of 1984. All items were also classified into one of three cognitive behaviour levels: Computation and Knowledge, Comprehension, and Application.

Description of the Instruments

Three booklets, R, S, T, each containing 50 multiple-choice achievement items were used for Grade 7. The pool of items assessed 14 objectives in seven domains: Number and Operation, Geometry, Measurement, Algebraic Topics, Probability and Statistics, Computers and Calculators, and Problem Solving. Each form also contained a common set of 16 items dealing with student background information. In addition, booklet R contained 10 items on *Mathematics in School*; booklet S had 15 items on *Gender and Mathematics*, and booklet T had 20 items on *Calculators and Computers*. All items were multiple-choice and students put their answers directly onto scannable answer sheets.

The achievement items each had five response choices. Four of these were possible answers, while the fifth option was "I don't know". Each of the three test booklets contained an equal number of test items in each of the seven domains. No achievement item appeared in more than one test booklet.

Two additional booklets, Q-1 and Q-2, were distributed on a random sample basis, per each 25 students. These forms were designed to gain information on how students approached measurement and problem-solving questions in an open-ended format. Results for the Q forms are reported in Chapter 6.

The student background items gave information on the students' age, gender, first language, mathematics program, homework, attitude, parents' education, and familiarity with SI metric units. The *Mathematics in School* scale contained 10 items on the students' perceptions of the importance, difficulty, and enjoyment of: fractions, decimals, percent, estimation, basic facts, equations, word problems, metric system, perimeter and area, and geometry. The sex stereotyping scale, *Gender and Mathematics*, contained 15 items designed to determine whether students perceived that males and females differ in such areas as their mathematical ability and need for a career. Other items assessed students' perceptions of their parents' interest, enjoyment, and ability in mathematics. The final scale, *Calculators and Computers*, contained 20 items on ownership, use, perceived use, and experience with these electronic devices. In addition, students were asked their opinion on further learning, confidence, enjoyment, competence, and use of computers in school subjects.

Of the seven domains tested, two dealt with content which was outside the prescribed British Columbia curriculum: Probability and Statistics, and Computers and Calculators. These topics, however, are included in the draft version of the newly revised mathematics curriculum guide. Information regarding students' knowledge in these topics will provide useful baseline data in any future review or Assessment of the

Mathematics curriculum in this province. The other five domains covered content normally taught up to and including Grade 7. Table 4-1 shows the number and percent of items in each domain and objective.

Table 4-1
Grade 7: Organization of Items

Domain/Objective	Number of Items	Percent
1. Number and Operation	**42**	**28**
Whole Numbers	15	10
Fractions and Decimals	18	12
Ratio, Proportion and Percent	9	6
2. Geometry	**36**	**24**
Geometric Figures	18	12
Geometric Relationships	18	12
3. Measurement	**15**	**10**
Metric Units	9	6
Perimeter, Area, and Volume	6	4
4. Algebraic Topics	**24**	**16**
Expressions, Equations, and Inequalities	18	12
Graphs	6	4
5. Probability and Statistics	**12**	**8**
Probability	6	4
Statistics	6	4
6. Computers and Calculators	**12**	**8**
Computers	6	4
Calculators	6	4
7. Problem Solving	**9**	**6**
Total	**150**	**100**

Description of the Population

The Grade 7 Mathematics Assessment was designed for all students enrolled in Grade 7 in 1985. According to statistics released by the Ministry of Education 35 413 students were enrolled at this level as of February 1985. The response rate was almost 95%.

Age, Sex, and Language Spoken

The data gathered from the background items indicate that, in May 1985, 47% of Grade 7 students were 12 years old and 44% were 13 years old. This age range is the one which should contain most students who enrolled in Grade One at age six. Six percent of the students were older than 13, and 3% were younger than 12. Approximately the same number of boys and girls participated in the Assessment.

Responses to the items regarding language reveal that 89% of the students first learned to speak English and 94% spoke English more often than another language at home. The great majority of students, some 98%, were taught mathematics in English. Ninety-two percent were registered in a regular program in English, 5% were in early French Immersion, 2% were in late French Immersion, and 1% were in *Programme-Cadre de Français*. Two percent of students reported that they sometimes went to an English as a Second Language class, and 5% said that they sometimes went to a Learning Assistance center for help in mathematics.

Homework Assignments

Students were asked how long it had taken them to complete their last homework assignment in Mathematics. The data in Table 4-2 shows that 81% of the students have homework assignments which take at most 30 minutes to complete.

Table 4-2
Grade 7: Homework Assignments

Length of Last Mathematics Homework Assignment	Percent
There have been no homework assignments	4
Between 1 and 10 minutes	29
Between 11 and 30 minutes	52
Between 31 and 60 minutes	12
More than one hour	3

Reasons for Studying Mathematics

Students were presented with a list of five reasons for studying mathematics and they were asked which ones were most important, and which ones were least important. Over half of the students, 58%, chose "to learn how to use mathematics to solve problems in the real world" as the most important. The least important choice was "to learn what mathematics is," chosen by 7% of the students. These results indicate an outlook which emphasizes the practical nature of mathematics.

Metric Usage

The current curriculum guide for mathematics in B.C. contains the following statement on metrication:

> The Federal Government has committed Canada to the change to the Metric System. This change will take place over a ten year period and is to be completed by 1981. Commencing in September, 1973, all primary pupils began to use the metric system as a standard of measurement. It has been agreed by the council of Ministers of Education, Canada, that all instruction in elementary and secondary schools should be predominantly metric by 1978. Mathematics for years K-12 will be completely metric by that date.

The information provided by the metric usage items shows that the desired state of metric usage has not yet been realized. Students clearly do not "think metric." Each of the metric usage items used in the Assessment consisted of a question followed by two statements. The students were told that both answers, one in SI metric units and the other in British units, were correct responses to the question. They were asked which one of the two answers came to mind first. The four items are reproduced in Table 4-3. Data from the Grade 8 level in the 1981 assessment are included in the chart in order to indicate trends.

Approximately 40% of the students are now using the metric system in thinking about mass, distance, and capacity. Temperature responses indicated a 61% level of metric usage, and this is likely related to a high level of familiarity with and usage of this concept in the home and in the broadcast media. Overall, the students' metric usage has increased in all areas since the 1981 Assessment but, with the exception of temperature, the rate of change has been slow.

Table 4-3
Responses to Metric Usage Items
(Percent)

	Grade 8 1981	Grade 7 1985
How much does a bicycle weigh?		
About 15 kilograms	26	38
About 35 pounds	72	62
What is the temperature in this room?		
About 20 degrees	38	61
About 70 degrees	60	39
How far is it from Prince George to Prince Rupert?		
About 700 kilometres	30	39
About 450 miles	67	61
How much gasoline can the gas tank in a large car hold?		
About 90 litres	23	40
About 20 gallons	74	60

Mathematics in School

Form R contained a scale entitled *Mathematics in School* which consisted of 10 items related to topics found in the Grade 7 mathematics curriculum. For each item, students were asked to indicate how important they thought the topic was, how easy the topic was for them, and how much they liked the topic. If the students were not sure what an item meant then they were instructed to leave the answer blank. Responses were made on a five-point scale which ranged from "not at all important" to "very important"; "very difficult" to "very easy"; and "dislike a lot" to "like a lot". The items and results are reported in Table 4-4. The figures in Table 4-4 are the sums of the proportions of students who chose important or very important, easy or very easy, and like or like a lot.

Table 4-4
Grade 7: Mathematics in School
(Percent)

	Important	Easy	Like
Operations on fractions	87	66	58
Operations on decimals	88	70	62
Working with percents	86	56	58
Learning about estimation	53	64	43
Memorizing basic facts	83	56	41
Solving equations	84	67	59
Solving word problems	60	43	37
Learning about the metric system	86	41	42
Working with perimeter and area	72	51	46
Doing geometry	69	51	52

Grade 7 students think that many of the traditional mathematics topics taught in school are important. The topics given the lowest importance ratings were learning about estimation, solving word problems, and doing geometry. Most of the topics were not considered easy, but the ones rated easiest were working with decimals, solving equations, working with fractions, and learning about estimation. Learning about the metric system, solving word problems, and doing geometry appear to be the most difficult topics for Grade 7 students to learn. The most popular topics were working with decimals, solving equations, and working with fractions and percents; but even these topics did not generate much enthusiasm. Topics disliked were solving word problems, memorizing basic facts, and learning about the metric system.

In viewing the entire scale, it appears that students feel that most of mathematics is fairly important. They find most topics easy to learn, but they dislike many of them. The topics that the Grade 7 students considered least important, learning about estimation and solving word problems, are considered most important by their mathematics teachers. In fact, these topics are so important that the *Agenda for Action* proposed by the National Council of Teachers of Mathematics in 1980 suggested that problem solving be the focus of school mathematics in the 1980s.

Calculators and Computers

Students responding to Form T completed a set of items designed to gain information about their use of and attitude toward calculators and computers. Two questions were also asked about students' use, confidence, and experience with computers.

Calculators

Although the majority of students (71%) indicated that they owned calculators, 32% never use a calculator outside of school and 72% never use one in school. When students were asked to indicate the ways in which calculators were used in the mathematics class, 62% responded that they were not allowed to use them. Four percent used them for games and fun, 22% to check answers, and 11% to calculate answers to problems. With regard to calculator use on tests, 92% of the students said they were not allowed, 6% said they were allowed on some tests, and less than 1% were allowed to use them on all tests. In 2% of the cases, students said that calculators were required on some tests. In general, the trend toward increased use of calculators observed in the 1981 assessment has been confirmed in the 1985 results.

The *Calculators and Computers* scale also contained two items which asked students their opinions about the appropriateness of using calculators in school. Students were divided in their opinion as to whether they should be allowed to use calculators. Thirty-nine percent said they should, 33% felt they should not, and 28% were undecided. A large proportion ,69%, said that even if they had calculators it would still be necessary for them to learn how to add, subtract, multiply, or divide by hand. Students in Grade 7 have mixed feelings about the use of calculators as a useful tool within the school. Their attitudes with respect to calculators may be conservative as they may be conditioned to a curriculum built around the development of skills in the use of algorithms.

Computer Use

On Form T at each grade level there were 13 computer-related items: three on computer use, and ten on students' attitudes toward computers. At present, some 32% of Grade 7 students have computers at home that do more than play games. Of this number, 46% use the computer for games, but 10% use it to write stories, 20% to write their own programs, and 14% to learn about mathematics or other subjects. Only 11% indicated that they had no experience with computers. Most of the students' experience comes from courses taken at school or elsewhere.

Attitudes Toward Computers

The data from the items on attitudes towards computers is summarized in Table 4-5. For each item the Strongly Agree and Agree proportions have been combined. The results show that, in general, Grade 7 students have positive attitudes towards computers. The majority of students, 84%, would like to learn more about computers and 74% believe that they should be taught about computers in school. Only 13% of the students feel helpless around computers, and 86% enjoy using them. Eighty-two percent believe that computers can be used to teach other subjects as well as mathematics, and 87% feel very strongly that their use is as appropriate for boys as for girls. As a group, students in Grade 7 appear to be undecided about whether or not computers are exercising too much control over people's lives.

Table 4-5
Grade 7: Attitudes Toward Computers
(Percent)

Item	Strongly Agree/Agree Grade 7
I would like to learn more about computers.	84
I feel helpless around computers.	13
Every student should be taught, in school, how to use the computer.	74
Computers can be used to teach mathematics.	82
Computers can be used to teach subjects other than mathematics.	84
Using computers is more suitable for boys than for girls.	6
I feel confident about being able to use computers.	63
I enjoy using computers.	86
Computers are gaining too much control over people's lives.	33
I am able to work with computers as well as most others my age.	54

Gender Stereotyping

The attitude scale included on Form S was entitled *Gender and Mathematics*. It contained 15 items each on a five-point scale with responses ranging from "Strongly Agree" to "Strongly Disagree". The scale was designed to determine the degree of sex stereotyping with regard to mathematics that exists among students. The results show that, for the most part, students do not display strongly stereotyped attitudes. For example, 71% of Grade 7 students disagreed with the statement "Men make better engineers than women," while only 13% agreed. Seventy-five percent disagreed with the statement "Boys need to know more mathematics than girls," while 11%

agreed. Eighty-seven percent believed "A woman needs a career just as much as a man does," and 7% disagreed.

Other items on the scale asked about parents' enjoyment of mathematics, the degree of interest and ability each parent displays in the student's mathematics homework, and the degree of importance each parent places on mathematics in the student's education. The data from these items indicate that although students believe that their fathers enjoy and are able to do mathematics more than their mothers, the differences are slight: less than 5% on any item. No more than 40% of the students responded that their mother or father really enjoyed mathematics, and 70% or more reported that their parents were able to help or were usually interested in helping with mathematics homework. Over 90% of the respondents agreed that their mothers and fathers think that learning mathematics is important. Moreover, 92% of parents want their children to do well in mathematics.

Domain 1: Number and Operation

By the end of Grade 7, students are expected to be able to perform the four basic operations of addition, subtraction, multiplication, and division with whole numbers, common fractions and decimals. Students at this level are also expected to have some understanding of number concepts, to be able to perform calculations involving ratio, proportion, and percent, and to be able to apply their computational skill to solve word problems. The items in the Number and Operation domain were intended to measure these skills and understandings. The items were grouped into three objectives: Number Concepts; Fractions and Decimals; and Ratio, Proportion, and Percent. The results for each objective of this domain are included in Table 4-6 along with the Interpretation Panel ratings. The Interpretation Panel rating for the domain as a whole was satisfactory.

Table 4-6
Grade 7: Number and Operation

Objective	Number of Items	Mean Percent Correct	Panel Rating
Number Concepts	15	70	S
Fractions and Decimals	18	58	M
Ratio, Proportion and Percent	9	62	S
Total	42	63	S

Number Concepts

The rating given by the Interpretation Panel for the 15 items in this objective was Satisfactory, and Table 4-7 contains a summary of the items with their ratings. The items are designated by the number of the item on the form on which they appear: for example, R/10 is Item 10 on form R.

Table 4-7
Interpretation Panel Ratings
Grade 7: Number Concepts

Rating	Items	Number of Items
Strong	S/3	1
Very Satisfactory	R/4, T/1, T/3, T/4	4
Satisfactory	R/1, R/3, S/1, S/2, S/4	5
Marginal	R/2, R/40, T/47	3
Weak	S/25, T/2	2

The Panel rating for the Number Concept objective was Satisfactory but, in their opinion, there was a weakness in the division of numbers with divisors of two or more digits. One of the division items rated Marginal was R/40, shown in Figure 4-1, in which only 67% of the students chose the correct response. The low correct response rate on this item is not particularly surprising because long division is difficult but the high "I don't know" rate is discouraging as instruction in division starts as early as Grade 4.

R/40. Divide: $45 \overline{)\,1232}$

		% of students
A.	25 remainder 7	9
B.	27 remainder 17*	67
C.	29 remainder 27	9
D.	209 remainder 17	5
E.	I don't know	8

Figure 4-1. Grade 7--Item R/40.

The two items rated Weak were S/25, an item on number theory dealing with properties of zero, and T/2, on order of operations. These items were very poorly answered with high "I don't know" responses. The Panel suggested that students should be given more experience with these types of items.

Fractions and Decimals

The Panel ratings of the 18 item results for this objective are shown in Table 4-8. Most of the ratings for this objective fall in the lower range of the scale: in the Marginal and Weak categories. The Panel rated as Satisfactory performance on a multi-step item involving adding and multiplying fractions, and three items on writing, subtracting, and dividing decimals. Marginal ratings were given to three items concerned with the addition, subtraction, and multiplication of fractions, as well as to three items dealing with the order of magnitude, subtraction, and division of decimals; and one on the conversion of a fraction to a decimal. The five items rated as Weak included: a two-step item on multiplication of fractions, two items concerning the multiplication and estimated addition of decimals, and two items related to the magnitude and construction of fractions.

Table 4-8
Interpretation Panel Ratings
Grade 7: Fractions and Decimals

Rating	Items	Number of Items
Strong	S/11	1
Very Satisfactory	T/15	1
Satisfactory	R/14,R/41,T/16,T/49	4
Marginal	R/15,R/42,S/13,S/26,T/9 T/17,T/48	7
Weak	R/16,R/43,S/12,S/27,S/48	5

The results for this objective reveal weaknesses in computational skill with fractions and decimals as well as in understanding concepts and estimating answers. The item with one of the lowest percentages of correct responses in the Grade 7 pool was item S/27, which is reproduced in Figure 4-2. On this item, students were asked to estimate the sum of three decimal fractions written in horizontal format. Only 35% of students chose the correct response while the remaining answers were spread equally across the rest of the distractors.

S/27. ESTIMATE the sum: 347.0 + 738.0 + 1.327

		% of students
A	1 000*	35
B	2 000	19
C	10 000	17
D	100 000	21
E	I don't know	07

Figure 4-2 Grade 7--Item S/27.

The result for S/26, shown in Figure 4-3 was rated Marginal. On this item, 46% of the students chose incorrect responses. The most popular incorrect response to the subtraction was to subtract the numerator from the whole number and then write the result over the denominator.

S/26. Subtract: 7 - 5/6

		% of students
A	7 1/6	8
B	7 5/6	7
C	2/6	21
D	6 1/6*	54
E	I don't know	9

Figure 4-3 Grade 7--Item S/26.

In general, students did not do as well on fraction items as on decimal ones. This may have occurred because fractions cannot be tied directly to place value. Members of the Interpretation Panel felt that the students did well in problems involving practical applications with food and money, for example T/49, but agreed that weakness was shown in rounding, in estimating, and in all fraction operations.

Ratio, Proportion and Percent

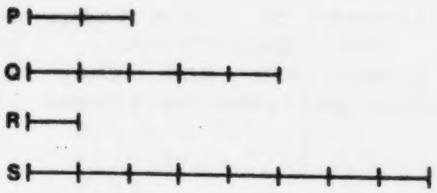
By the time students reach the end of elementary school, they are expected to have a fair degree of proficiency with ratio, proportion, and percent. In particular, students are expected to be able to solve simple proportions, to compute percentages, and to solve problems using percent. The Panel rating for the results of this objective was Satisfactory, and the items are listed in Table 4-9.

Table 4-9
Interpretation Panel Ratings
Grade 7: Ratio, Proportion, and Percent

Rating	Items	Number of Items
Strong	-	0
Very Satisfactory	R/9,T/10,T/11	3
Satisfactory	S/19,S/49,T/39	3
Marginal	R/37,S/50	2
Weak	R/8	1

The results the Panel rated as Very Satisfactory included items on scale drawings, discount, and simple proportion. The students also performed Satisfactorily on items dealing with finding a percent of a number, determining scale distance, and placing a rational number on a number line. Marginal ratings were given on a proportion item, and an item that involved converting a fraction to a percent. The one Panel rating of Weak performance was assigned to item R/8, which asked students to identify line segments in a ratio of 1 to 4: see Figure 4-4. From the rate of 30% for the "I don't know" response in the item, it is clear that students have great difficulty picking out equal ratios even when they are presented pictorially. The Interpretation Panel felt students were Weak in identifying proportions, and that there should be more emphasis placed on understanding equivalent ratios.

R/8. Which pair of line segments shown below have lengths which are in the ratio of 1 to 4?



		% of students
A	P and Q	21
B	R and S	10
C	P and S *	36
D	R and T	3
E	I don't know	30

Figure 4-4 Grade 7--Item R/8

The Interpretation Panel commented that the test results showed some strength in the area of scale drawings and in finding a percent of a number. Item S/19 is reproduced in Figure 4-5 and illustrates the latter type of question. Even though 63% of the students responded correctly to this item, many chose "I don't know." Moreover students appeared to be weak in applying estimation skills that would lead them to select a reasonable answer.

S/19. What is 24% of $150.00?

		% of students
A	24/100	8
B	$24.00	9
C	$36.00	63*
D	$174.00	4
E	I don't know	15

Figure 4-5 Grade 7--Item S/19.

Summary

The overall Panel rating of the results in the Number and Operation domain was Satisfactory. Over the three objectives a number of conclusions may be made. Student performance on items evaluating computational skills with whole numbers is

Satisfactory, but students have Marginal ability in computation with fractions and decimals. When fraction and decimal items are compared, students have a higher degree of success with decimals. These results may be because of the complexity of fractional ideas and the fact that in many cases they cannot be reinforced by place value concepts. Ratio and percent concepts are Satisfactory, but students have difficulty with proportion and they are not adept at estimating or checking the reasonableness of their answers.

Domain 2: Geometry

By the end of elementary school students have had seven years of experience working with, constructing, classifying, and listing the parts and properties of regular geometric objects. In Grade 7 it is expected that students will be ready to use appropriate vocabulary, demonstrate their knowledge, and apply their experience to explore new relationships in geometry. The items in the Geometry domain intended to measure these skills and understandings. It should be noted that the 1985 Assessment gave more emphasis to Geometry than previous Assessments.

There were 36 items in the Geometry domain. Table 4-10 contains data on the Geometric Figure and Geometric Relationship objectives which make up this domain.

Table 4-10
Grade 7: Geometry

Objective	Number of Items	Mean Percent Correct	Panel Rating
Geometric Figures	18	57	S
Geometric Relationships	18	50	M
Total	36	53	M to S

The overall rating for the Geometry domain was Marginal to Satisfactory. The ratings for each objective are discussed below.

Geometric Figures

This objective included 18 items and the overall rating given by the Interpretation Panel was Satisfactory. Table 4-11 contains a summary of the items and the ratings assigned to each.

Table 4-11
Interpretation Panel Ratings
Grade 7: Geometric Figures

Rating	Items	Number of Items
Strong	-	0
Very Satisfactory	R/12,S/10,S/20,S/21,T/13	5
Satisfactory	S/5,S/6,T/12,T/14,T/42	5
Marginal	R/13,R/20,R/38,R/39,S/9 T/40	6
Weak	R/19,T/27	2

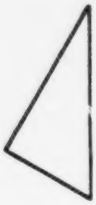
The five items rated Very Satisfactory included three which tested concepts relating to planes, parallel lines, and sides of an object, and two items concerned with plane and solid figures. The five items rated Satisfactory relate to the number of edges on a cube, diameter, parallel segments, proper representation of a line, and the net necessary to construct a pyramid. Of the remaining eight items, six were knowledge questions which assessed the students' understanding and recall of vocabulary such as inside and outside, obtuse angle, quadrilateral, circumference, perpendicular, and acute angle.

Item R/38 is reproduced in Figure 4-6. In this item students had great difficulty in identifying a quadrilateral. The hexagon and pentagon distractors both received approximately a quarter of the responses. It appears that students are not familiar with the vocabulary and classification of polygons.

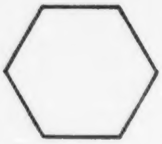
The item that had the lowest correct response rate, R/19, is reproduced in Figure 4-7. It appears that students ignored key vocabulary and may have poor skills when dealing with the visualization of solid objects in their two-dimensional representations. When asked how many pairs of parallel planes are in the figure, 22% of the respondents picked the correct number of planes, 20% picked the number of planes drawn with solid lines and 48% chose the total number of planes. The item is particularly difficult because students have to read the item carefully, recall information on the meaning of the words "parallel" and "pair," and then attempt to solve this question.

R/38. Which one of the following is a quadrilateral?

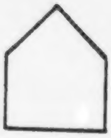
A.



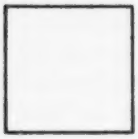
B.



C.



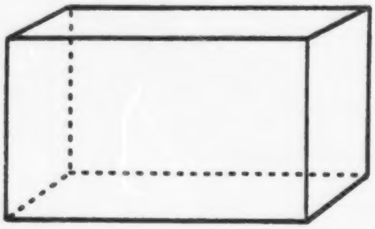
D.



E. I don't know.

Figure 4-6 Grade 7--Item R/38

R/19. How many pairs of parallel planes are there in the following figure?



	% of students
A 2	4
B 3	22*
C 4	20
D 6	48
E I don't know	6

Figure 4-7. Grade 7--Item R/19.

The Interpretation Panel believed vocabulary is vital to an understanding of Geometric Figures, and that students' performance in this area was Weak. They concluded that it would be of great benefit to have a more specific curriculum in Geometry.

Geometric Relationships

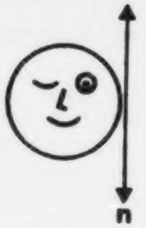
The 18 items in this objective covered a wide range of content, including spatial reasoning, elementary theorems in geometry, and symmetry. Panel ratings for the individual items are presented in Table 4-12. The overall Panel rating of the results for this objective was Marginal.

Table 4-12
Interpretation Panel Results
Grade 7: Geometric Relationships

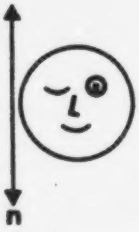
Rating	Items	Number of Items
Strong	-	0
Very Satisfactory	S/42	1
Satisfactory	R/26,R/31,R/32,R/44,R/45 S/36,S/39,T/18,T/19	9
Marginal	R/27,S/37,S/40,S/41,T/14 T/28,T/29,T/43	8
Weak	-	0

The majority of the items in this section received Marginal to Satisfactory ratings. The one item result that was rated Very Satisfactory was an item on three dimensional geometry. Five items that were given Satisfactory ratings concerned topics in transformational geometry and tesselations. Other items rated Satisfactory included those which asked students to place a square block in a hole in a flat template, estimate the number of degrees in an angle, calculate the distance between two points, and identify congruent rectangles. One of the items with a Satisfactory rating is reproduced in Figure 4-8. This item is one of five which dealt with the transformational geometry concepts of translation (slide), reflection (flip), and rotation (turn). This item, R/31, and its parallel question, R/27, were concerned with reflections of figures. The vocabulary in R/31 used the term "reflection" while R/27 used the word "flip." The students' correct response rate was higher in R/31 which used the more difficult term indicating that they were very familiar with the concept of reflection in a mirror, but interpreted "flip" to mean turn upside down in item R/27. The responses in Figure 4-8 also show the typical flat distribution pattern found in four of the five items dealing with this concept. The students found R/31 difficult with a correct response rate of 58%, but the low "I don't know" rate of 6% showed that they had a high degree of confidence when attempting to solve this item.

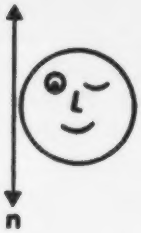
R/31. Which of the following diagrams shows the reflection of the face in line n?



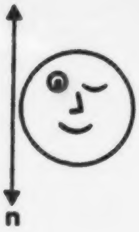
A.



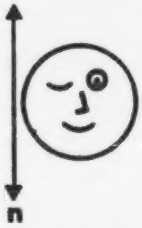
B.



C.



D.

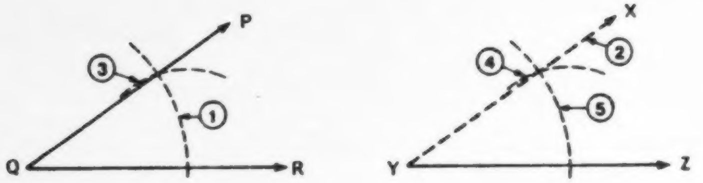


E. I don't know.

Figure 4-8. Grade 7--Item R/31.

Of the eight items that were rated Marginal by the Panel two were concerned with symmetry; two dealt with copying and bisecting an angle; two were on transformational geometry (rotations and flips); and the remaining two items had to do with finding the diameter of a circle given the radius, and recognizing that equal segments are congruent. There were a number of items with a high "I don't know" response rate, and one of these items, S/40, is reproduced in Figure 4-9. The very low correct student response rate for this item indicates both the difficulty and complexity. The rate may be explained either by the fact that students may never have seen the question posed in this format before or that constructions have a very low priority and are not being taught.

S/40. The diagram below illustrates a ruler-and-compass method of copying an angle. If the construction lines are labelled as shown in the figure, what order could be followed when completing the construction?



	% of students
A 1,5,2,3 and 4	8
B 1,5,3,4 and 2	26*
C 1,5,3,2 and 4	14
D 1,5,4,3 and 2	12
E I don't know	38

Figure 4-9. Grade 7--Item S/40.

Summary

The most striking pattern which emerges from these responses is the number of the items that were rated Satisfactory or Marginal. Of the 36 items in this domain, 28 or 78% are in these two categories. Even though many of the questions dealt with motion geometry, a topic not emphasized in the curriculum guide, the results are poor. The Panel felt that instruction in geometry was being neglected. Panel members pointed out that because geometry is traditionally taught at the end of the year and because it usually appears at the end of the textbooks, it tends to get left out. This problem is compounded if teachers in later grades assume that the required material has been taught. The Panel suggested that instruction in geometry be given a higher priority, that geometric vocabulary be incorporated into other subject areas, and that curriculum objectives in the curriculum guide be rewritten to make them much more specific.

Domain 3: Measurement

The Measurement domain consisted of 15 items grouped under two objectives: 9 items on Metric Units, and 6 items on

Perimeter, Area, and Volume. Table 4-13 summarizes the results for the Measurement domain.

Table 4-13
Grade 7: Measurement

	Items	Mean Percent Correct	Panel Rating
Metric Units	9	60	M
Perimeter, Area, and Volume	6	44	M
Total	15	54	M

The overall rating for the Measurement domain was Marginal. The ratings for each objective are discussed below.

Metric Units

The Metric Units objective consisted of 9 items dealing with temperature, length, mass, and capacity. The Panel ratings are found in Table 4-14. The overall rating for this objective was Marginal. The two items rated Very Satisfactory dealt with the unit for the mass of sugar, and with conversion from metres to centimetres. Satisfactory items dealt with the capacity of water in a glass and the thickness of a dime. The four items that were Marginal dealt with the temperature of the air on a sunny day, the temperature of boiling water, the weight of a ten-year-old child, and the meaning of the prefix "centi." One item rated Weak concerned the conversion of grams to kilograms.

Table 4-14
Interpretation Panel Results
Grade 7: Metric Units

Rating	Items	Number of Items
Strong		0
Very Satisfactory	R/49,T/35	2
Satisfactory	S/38,T/37	2
Marginal	R/48,S/14,S/15,T/36	4
Weak	R/21	1

Two items in this objective, R/49 and R/21, were concerned with the conversion of metric units. Figure 4-10 contains Item R/49 which asked students to convert from metres to a smaller unit of length. This item had a correct response rate of 76% and an "I don't know" response of 3%. By comparison, the other item R/21, had a 37% correct response rate and an "I don't know" response of 16%. This second item asked students to convert 250 grams to the larger unit kilograms, and involved decimals. It appears that students have some skill in converting metric units but the direction of the conversion is a strong factor in their success rate, especially if decimals are involved.

R/49. 5 metres is the same length as:

	% of students
50 centimetres	9
500 centimetres	76*
50 millimetres	4
500 millimetres	4
I don't know	3

Figure 4-10. Grade 7--Item R/49.

Performance on the two items involving temperature, S/14 and T/36, was rated Marginal. Sixty-one percent of the students correctly identified 100°c as the boiling point of water in item S/14. This response rate is what might be expected for these items and is consistent with the results obtained in the Metric Usage section of this chapter. However on item T/36, shown in Figure 4-11, only 50% of the students correctly estimated the temperature on a sunny summer day. The two other incorrect responses still indicate a strong preference for the non-metric unit of temperature measure.

T/36. The temperature on a sunny summer day would most likely be:

		% of students
A	5° Celsius	3
B	25° Celsius*	50
C	55° Celsius	20
D	85° Celsius	21
E	I don't know	5

Figure 4-11. Grade 7--Item T/36.

It appears that, in spite of all the metric usage in the broadcasting media and work in school classrooms, students are still unable to handle metric quantities competently.

Perimeter, Area, and Volume

At the Grade 7 level most students are expected to be able to calculate areas and perimeters of rectangles and triangles. They should also be able to calculate the volumes of right prisms. Of the six items related to these topics, three dealt with area, two with perimeter, and one with volume. The Panel ratings are found in Table 4-15. The overall rating for this objective was Marginal.

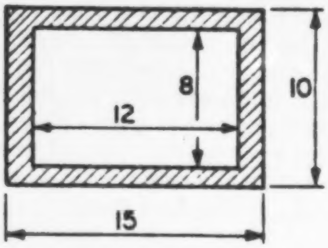
Table 4-15
Interpretation Panel Ratings
Grade 7: Perimeter, Area, and Volume

Rating	Items	Number of Items
Strong	-	0
Very Satisfactory	R/50	1
Satisfactory	S/22	1
Marginal	T/38,T/44	2
Weak	R/28,S/16	2

The one item that was rated as Very Satisfactory was pictorial and required finding the diagram having the same area as an example. The single item that was Satisfactory concerned finding the volume of a box given the dimensions. Most of the items fell into the Marginal and Weak categories. Two Marginal questions had to do with finding the perimeter of a rectangular garden and the area of a picture frame. The results rated Weak by the Panel involved finding the area of a triangle and calculating the perimeter of a rectangle given the dimensions indirectly.

Generally students tended to perform poorly on all the items that involved word problems. Item T/44 reproduced in Figure 4-12 illustrates one of the three area questions involving multi-step procedures for finding the areas of parts of regions. Results were rated Marginal, and there was a high "I don't know" response rate of 20%. Although there are various methods of solving this item, students were not even able to distinguish which inside dimensions needed to be multiplied together in order to obtain the area necessary to be subtracted from the total area to obtain the correct answer.

T/44. What is the area of the shaded portion of this figure?



		% of students
A	54	30*
B	96	27
C	120	9
D	60	11
E	I don't know	20

Figure 4-12. Grade 7--Item T/44.

An item, shown in figure 4-13, which involved finding perimeter was rated as marginal. Student responses show a tendency to incorrectly take any numbers that are given and either add them or multiply them to "get" the answer. Students do not appear to consider what the question asks for or take sufficient care in reading the problem.

T/38. Mr. Jones put a fence around his rectangular garden. The garden is 10 m long and 6 m wide. How many metres of fencing did he use?

		% of students
A	16 m	16
B	30 m	3
C	32 m	46*
D	60 m	31
E	I don't know	2

Figure 4-13. Grade 7--Item T/38.

Summary

The Interpretation Panel was unhappy with the general result for this domain and assigned it a Marginal rating. Students tend not to have a good understanding either of metric units or perimeter, area, and volume. The Panel viewed this as disappointing as they consider knowledge of the Metric system as a vital life skill. General performance on word problems and multi-step problems was also quite poor.

Overall, only 6 out of 15 ratings were Satisfactory to Very Satisfactory and this indicates clearly the lack of a basic conceptual understanding of Measurement.

Domain 4: Algebraic Topics

The Algebraic Topics domain consisted of 24 items that were grouped under two objectives: 18 items in Expressions, Equations and Inequalities, and 6 items in Graphs. Table 4-16 summarizes the number of items, the mean percent correct, and the Panel ratings for each objective. The overall rating for the domain results was Satisfactory.

Table 4-16
Grade 7: Algebraic Topics

Objective	Number of Items	Mean Percent Correct	Panel Rating
Expressions, Equations, and Inequalities	18	44	M
Graphs	6	76	VS
Total	24	52	S

Expressions, Equations, and Inequalities

This objective consisted of 18 items dealing with algebraic sentences and concepts. The overall rating for students' performance on this objective was Marginal. Panel rating results for each item are summarized in Table 4-17.

Table 4-17
Interpretation Panel Ratings
Grade 7: Expressions, Equations, and Inequalities

Rating	Items	Number of Items
Strong	-	0
Very Satisfactory	T/26	1
Satisfactory	R/29,R/35,R/36,S/24,T/45	5
Marginal	R/30,R/34,S/23,S/30,S/31 S/32,S/33,T/24,T/25,T/46	10
Weak	R/33,T/15	2

The item rated Very Satisfactory asked students to translate an English sentence into one using an algebraic inequality. The five items rated as Satisfactory were concerned with basic algebra concepts, translating from English to algebraic sentences, substituting numbers into expressions, and determining additional information needed in a question. Overall the "I don't know" responses in this section averaged over 11%, perhaps because students encountered algebra for the first time. Figure 4-14 contains Item R/35 which illustrates this pattern. In addition to the high "I don't know" rate, 16% of the students chose 11 as a possible response in this item indicating that they did not understand that $2n$ means "2 times n" not "2 plus n".

R/35. If $n = 5$, then $2n + 4 =$

		% of students
A	14	51*
B	18	6
C	20	10
D	11	16
E	I don't know	15

Figure 4-14. Grade 7--Item R/35.

The 10 Marginal items dealt with various aspects of algebra. One item, R/34, asked students to solve an algebraic equation and another, T/40, to list the whole numbers less than 6. A related item, S/30, asked for the steps in a solution of an equation. Another item, S/31, which involved the meaning of the product 3a was answered correctly by 35% of the students, while 35% gave an "I don't know" response. Of the remaining five Marginal questions three asked the students to choose an algebraic expression to represent a given situation, for example, "which of the following is the same as '18 more than a number equals 44'?" The students did well with these items, with a greater than 40% correct response rate and average "I don't know" responses of less than 10%. The last two items were concerned with substituting numbers into a formula, and finding the generalized answer to a problem. Item S/32, shown in Figure 4-15 illustrates a type of question where students were asked how one variable in an algebraic equation changes when the other variable is increased. The Students' response pattern for the incorrect answers was very uniform indicating that they were unfamiliar with this concept. In addition, students appear to have few analytic skills or techniques which would help them with items of this type. The Interpretation Panel rated performance on these items as Marginal instead of Weak because of the non specific nature of algebra in the Curriculum. In their view, there was a distinct weakness in the transfer of basic concepts and operations to more abstract expression.

S/32. If $y = 15 - x$
what happens to y as x increases?

		% of students
A	y decreases	39*
B	y increases	16
C	y remains the same	17
D	cannot tell what happens	13
E	I don't know	14

Figure 4-15. Grade 7--Item S/32.

The remaining two items in this objective were rated Weak. One item was on the distributive principle and the other was on completing the pattern in a table with an algebraic term. In the latter item, shown in Figure 4-16, it was clear, from the low "I don't know" rate and 61% incorrect response for the next "number" in the table, that students were familiar with this type of question but appeared unable to make the transition from the specific to the general case. The Panel suggested that there be more exposure to simple algebra expressions to facilitate transfer of simple concepts and expressions.

T/5. When the input is x the output is:

Input	Output
3	7
4	9
5	11
6	13
7	15
8	17
x	__

		% of students
A	19	61
B	$2x - 1$	2
C	$2x + 1$	15*
D	x	9
E	I don't know	12

Figure 4-16. Grade 7--Item T/5

Graphs

Six items were used to assess students' ability to construct and interpret graphs. The Panel rated performance on all six items as Satisfactory or better. The overall rating for this objective was Very Satisfactory. The ratings for this objective are summarized in Table 4-18.

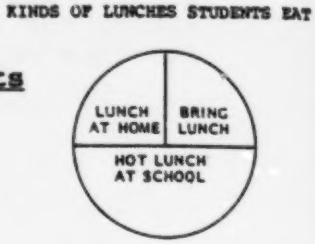
Table 4-18
Interpretation Panel Ratings
Grade 7: Graphs

Rating	Items	Number of Items
Strong	R/46	1
Very Satisfactory	S/43,S/44,T/6,T/23	4
Satisfactory	R/5	1
Marginal	-	0
Weak	-	0

The items that are discussed in this objective deal with various types of graphs: bar, line, and circle. The item rated Strong concerned finding the time of the highest temperature reading. The four Items regarded as Very Satisfactory included two on interpreting bar graphs, one circle graph on estimating the number of hours of T.V. watched, and a line graph to determine the rainfall more than 5 cm.

The item rated as Satisfactory required information to be obtained from a circle graph on how many students went home for lunch from a certain population of students. This item is shown in Figure 4-17. Students did not read and interpret this item very carefully. Twelve percent incorrectly chose 25 as a response, correctly seeing the appropriate area as a quarter of the circle but not taking into account the fact that it represented a quarter of the 400 students. Another 12% chose 200 as the answer and completely ignored the other half of the students represented by those buying hot lunches at school. The Interpretation Panel felt that Graphs would be more appropriately placed in another area and that the weighting of graphing was disproportionately low for the total number of items tested in this domain.

R/5. If 400 students eat lunch, about how many go home for lunch?



	% of students
25	12
100*	66
200	12
300	2
I don't know	7

Figure 4-17. Grade 7--Item R/5.

Domain 5: Probability and Statistics

The Probability and Statistics domain consists of 12 items that were grouped under two objectives: 6 items in Probability and 6 in Statistics. This domain is clearly non-curricular in content. The Interpretation Panel declined to give an overall rating to the domain or the two objectives. They did however rate individual questions and this data is summarized in Table 4-19. The Panel commented that they were impressed that students did so well on topics not presently in the curriculum.

Table 4-19
Grade 7: Probability and Statistics

Objective	Number of Items	Mean Percent Correct	Panel Rating
Probability	6	44	-
Statistics	6	43	-
Total	12	43	-

Probability

The items in the Probability objective were designed to give baseline data on the amount of knowledge that students have about the probable outcome of common events. The Panel did not give a rating for the objective as a whole but ratings for individual items are listed in Table 4-20.

Table 4-20
Interpretation Panel Results
Grade 7: Probability

Rating	Items	Number of Items
Strong	-	0
Very Satisfactory	R/47,T/30,T/31	3
Satisfactory	S/17,S/18	2
Marginal	R/6	1
Weak	-	0

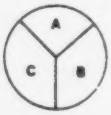
Of the three items rated Very Satisfactory two were concerned with choosing the spinner that would give the best chance of winning, and one with the probability that rain would fall. On half of the six items in this objective students achieved a correct response rate of 50% or more. The average "I don't know" rate on all the items was 10%. The two Satisfactory items asked for the probability that one or another event would occur when a die was rolled and the probability that a number would be picked from a bowl. The item rated Marginal was concerned with the probability that two dimes would both land heads when they are flipped.

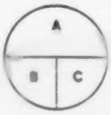
Item T/30 in Figure 4-18 contains an example of one of the spinner items. The item asks students to analyze a sample set of data and interpret the results obtained to help select the spinner that was most likely used. The students did very well, considering the high level of interpretive skills necessary, with 56% choosing the correct response. Two of the other distractors had half of the spinner area labelled as 'A' which was very close to the stated value of 55 given in the table.

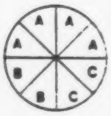
T/30. Sparky Spencer spun a spinner 100 times and made a record of his results.

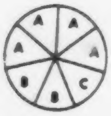
Outcome	A	B	C
Number of times	55	30	15

Which spinner did he most likely use?

A. 

B. 

C. 

D. 

E. I don't know.

Figure 4-18. Grade 7--Item T/30.

Statistics

Items in the Statistics objective assessed students' ability to interpret and make judgments about statements involving statistical information. Overall student achievement on this objective was not rated and individual item ratings were poorer than those given to the Probability items. Table 4-21 summarizes the Panel ratings for this objective.

Table 4-21
Interpretation Panel Ratings
Grade 7: Statistics

Rating	Items	Number of Items
Strong	R/10	1
Very Satisfactory	-	0
Satisfactory	S/45	1
Marginal	R/7,S/46,T/7,T/32	4
Weak	-	0

The items rated Strong and Satisfactory involved picking out the largest gain in population and calculating the average of four numbers, respectively. The four Marginal items concerned: vocabulary, organizing data in a frequency of occurrence table, finding the average age of four children, and making observations about a median test mark. Two of the six items showed a very low correct response rate as well as a high "I don't know" rate of about 40%. Item T/7 is representative of these questions and is reproduced in Figure 4-19. The students were asked to determine which table represented a set of data listed in the question. The response pattern was uniform over the incorrect answers indicating that students could not interpret the information presented in the tables. The use of the word "frequency" may have caused some confusion but students have worked with the process of ordering and transferring both qualitative and quantitative information into tables from an early age. Furthermore, the transference of data from tables into pictographs and graphs is a common activity in the elementary curriculum. It is clear that students have not retained much skill in systematically organizing and representing data from the manipulative work done in the primary grades. This is unfortunate since the skill necessary to determine the best way to represent and display data is very important in the physical and biological sciences.

T/7. Test marks: 3,4,5,4,5,5,5,3,3,1,4,5,0,4,5.

Which one of the following tables represents this data?

A.

mark	frequency
0	1
1	1
2	0
3	3
4	4
5	6

B.

mark	frequency
0	1
1	2
2	1
3	3
4	3
5	6

C.

mark	frequency
0	1
1	1
2	0
3	3
4	4
5	5

D.

mark	frequency
0	0
1	1
2	2
3	3
4	4
5	5

E. I don't know.

Figure 4-19. Grade 7--Item T/7.

Domain 6: Computers and Calculators

The Computers and Calculators domain consisted of 12 items that are grouped under two objectives: Computer Literacy and Calculators. Neither of these topics is in the present curriculum. The items in Computer Literacy are specific and relate to information on the actual background manipulative skills that students have acquired from the ready availability of calculators at home and from computers at home and in schools. The Interpretation Panel did not rate the domain overall but again rated individual items. Table 4-22 gives the Mean Percent Correct responses for the domain.

Table 4-22
Grade 7: Computers and Calculators

Objective	Number of Items	Mean Percent Correct	Panel Rating
Computer Literacy	6	40	-
Calculators	6	38	-
Total	12	39	-

Computer Literacy

The six items in the Computer Literacy objective assess the students' knowledge about computers as well as their ability to understand and follow instructions. Table 4-23 summarizes the Panel ratings.

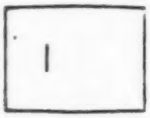
Table 4-23
Interpretation Panel Ratings
Grade 7: Computer Literacy

Rating	Items	Number of Items
Strong	R/23	1
Very Satisfactory	T/33	1
Satisfactory	R/24,S/8	2
Marginal	S/7,T/34	2
Weak	-	0

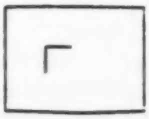
The item rated Strong dealt with determining the set of instructions necessary to draw a square, while T/33, rated Very Satisfactory, asked for recognition that a program was the name used for the list of instructions given to a computer. The two items rated Satisfactory asked students whether they recognized what the symbol "*" meant, and required them to apply an operation in a hypothetical computer. The two items rated Marginal were concerned with following a complex set of instructions and obtaining a numerical value for a computer expression.

The item rated Strong is shown in Figure 4-20. The results may be attributable to the greater availability of computers in the elementary school and to an increased popularity and use of languages such as LOGO.

R/23. An imaginary computer can draw pictures on a television screen.
When given the instruction MOVE it will draw a picture like this



When given the instruction MOVE R MOVE
it will draw this picture



Which one of the following sets of instructions would draw a square?

		% of students
A	R R R R	3
B	MOVE R R R	9
C	MOVE MOVE MOVE MOVE	5
D	MOVE R MOVE R MOVE R MOVE	75*
E	I don't know	8

Figure 4-20. Grade 7--Item R/23.

In general, students did very well with these items considering Computers are not in the mathematics curriculum. On half of the items "I don't know" responses averaged 3[illegible]%, and students had difficulty with questions involving complex instructions and mathematical terms and symbols. The Interpretation Panel did not give an overall rating to this objective and commented on the pressing need for a specific computer curriculum with consistent hardware.

Calculator Use

The Calculator Use objective consisted of 6 items dealing with the vocabulary and use of hand held calculators. The Panel did not give an overall rating to this objective but rated individual items. Table 4-24 summarizes this information.

Table 4-24
Interpretation Panel Ratings
Grade 7: Calculator Use

Rating	Items	Number of Items
Strong		0
Very Satisfactory	R/11	1
Satisfactory	R/22,S/28,T/21,T/22	4
Marginal	S/29	1
Weak	-	0

Each of the items in this objective included a pictorial representation of a calculator. The item rated Very Satisfactory asked the students about the function of the MR key. The four Satisfactory items were concerned with the analogy of a calculator to a person, the M+ key function, the sequence of keystrokes necessary to calculate a percentage, and the procedures necessary to calculate a square root. Item S/29 dealt with the CE key function.

Item S/28, shown in Figure 4-21, is concerned with the function of the M+ key. The low correct response rate of 38% for the M+ key item compared with a 41% incorrect response rate for the MR item indicates that students are not familiar with the use of these calculator keys. When it is recalled that 71% of students claimed that they own calculators, there is a clear indication that some instruction in their use should occur in schools.

While the Interpretation Panel did not give a rating for this objective the results seem acceptable for a non-curriculum subject area. Five of the six items were rated at least Satisfactory and the "I don't know" responses, overall, averaged 10%. Students' high confidence in their knowledge was not reflected in correct responses to the items, however, as these ranged from 32% to 40% in the four Satisfactory questions. Seventy-one percent of the students indicated that they own calculators but the results here show that they know little about how to use them to perform simple calculations.

If this is to become a curriculum topic the Panel feels there should be some direction as to the appropriate use of calculators and that there should be clear guidelines as to the types of calculators actually used in classrooms.

S/28. Which one of the following keys would you push to store the answer to a calculation so you could use it later on?

A. M+

B. MR

C. CE

D. +

E. I don't know.

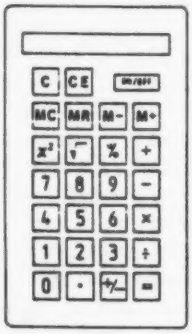


Figure 4-21. Grade 7--Item S/28.

Domain 7: Problem Solving

The Problem Solving domain consisted of 9 items distributed across the three booklets. Two questions were designed to evaluate students' use of a variety of appropriate problem solving techniques, and the remaining 7 items to determine how well problem solving skills were applied. The Interpretation Panel rated the domain and objective as Satisfactory. Table 4-25 contains a summary of the item ratings.

Table 4-25
Interpretation Panel Ratings
Grade 7: Problem Solving

Rating	Items	Number of Items
Strong	-	0
Very Satisfactory	T/8	1
Satisfactory	R/17,R/18,S/34,S/35,T/20 T/50	6
Marginal	R/25,S/47	2
Weak	-	0

Item T/8, rated Very Satisfactory, was concerned with the problem solving technique best suited to finding how many pieces were obtained after 10 cuts of a pie. The six items rated Satisfactory required students to demonstrate their problem solving ability. Item T/20,shown in Figure 4-22, is typical of this group. The item required students to deal with several pieces of information, and there is no standard procedure for solving such a problem.

T/20 I am a number between 25 and 40.
I have a remainder of 2 when divided by both 6 and by 9. Who am I?

		% of students
A	26	6
B	29	7
C	32	12
D	38	61*
E	I don't know	14

Figure 4-22. Grade 7--Item T/20.

Items R/25 on problem solving and S/47 on problem solving techniques were rated as Marginal. Figure 4-23 shows Item S/47.

On this item, students were asked about the process by which they might solve the problem rather than for the answer to the problem. The responses may indicate that students have little familiarity with the terminology of problem-solving strategies. For example, students may have thought of working backwards as trying an answer first, and this approach would be similar to guess and check.

S/47 I am thinking of two numbers. When you add them you get 36. When you subtract them you get 8. To find both numbers the most useful problem-solving technique would be to

		% of students
A	guess and check	27*
B	draw a picture or diagram	13
C	solve a simpler problem	8
D	work backwards	42
E	I don't know	6

Figure 4-23. Grade 7--Item S/47.

The overall Interpretation Panel rating for this domain was Satisfactory. The results indicate that students have fair problem solving skills. Seven out of the nine items were rated Satisfactory or better with an average correct response rate of 60%. The "I don't know" responses were no greater than 15% on any one item, and averaged 9% overall. The Panel suggested that a more thorough outline of problem solving techniques be included in the curriculum guide and that the development of such techniques continue to be a major focus in the teaching of mathematics.

Reporting Categories

Students' achievement in mathematics is the result of a large number of factors, both external and internal, that affect their learning. Age, sex, and many other attributes inherent in the student combine with curricular and environmental variables, such as teacher differences, to influence overall performance. A great deal of information concerning the relationships between student background variables and achievement was collected in the Assessment. The information was too extensive to be completely discussed in a report of this length. From the large number of variables believed to be related to achievement, a smaller set was selected and the relationship of these factors to performance was studied.

In the sections that follow, all the results reported are based on group comparisons. No attempt is made to imply that cause-and-effect relationships exist since the Mathematics Assessment was not specifically designed to identify such relationships. Thus, for example, while the results show some gender differences in performance in some domains this does not imply that one's achievement is determined by one's sex. All that can be said is that on the basis of the Assessment data, there appears to be a relationship. It remains for other studies designed as follow-ups to seek causal relationships.

Sex Differences

There has been much interest shown in the differences in mathematics achievement between boys and girls. In the 1981 Assessment, the data appeared to support a growing body of literature which indicates that, starting around Grade 8, girls outperform boys only in those areas of mathematics at the lower cognitive levels.

The 1985 Assessment data were analyzed in order to determine if there were any sex-related differences. Based on the sample of all students writing the tests, there are differences in achievement between boys and girls in some domains. In particular, boys' performance was better than girls' in three of the seven domains: Measurement(M=56,F=52), Probability and Statistics(M=45,F=42), and Computers and Calculators(M=41,F=37). The girls achieved higher than the boys in Problem Solving(M=52,F=54) and the groups were the same in Number and Operation(M=63,F=63), Geometry(M=54,F=53), and Algebra(M=52,F=52).

Over the seven domains, boys achieved a mean percent correct response rate of 54% to the girls' 53%. There was no more than a 4% difference between the mean correct responses for the two groups in any one domain. There were approximately the same number of Grade 7 males and females writing the 1985 Assessment.

First Language

One of the background items asked students whether or not English was their first language. Results show no clear pattern of superior achievement based on this partitioning of the population. In 1977 different questions were used to classify students according to language first learned, and items were grouped under different domains. At that time, results indicated that students who had a non-English-speaking background performed well in mathematics and were not disadvantaged in that respect. Results of the 1981 Assessment indicated that students with a non-English-speaking background did about as well as those students with an English-speaking background. In the 1985 Assessment students who had a non-English-speaking background were consistently slightly higher in achievement than any other group across the seven domains. Differences were very small, and were less than 2% between the groups surveyed. An interesting exception occurred in the Computers and Calculators domain where students who used languages other than English at home out-performed all other groups by 12%.

Metric

The background items which dealt with metric usage have been discussed previously. There has been some interest in the differences in mathematics achievement for students who are totally metric (those students who chose the metric responses in all four metric items in the Background information) over those that are not. The 1981 Assessment report does not comment on this aspect of Metrication. Results from the 1985 Assessment indicate that students who are totally metric score at least 3% higher in each of the seven domains than those that are partially metric. The difference in achievement compared to those students that are still totally non-metric (students who chose the Imperial responses in all four metric items in the Background information) was 5% or greater in every domain category. The overall total mean percent correct figure for this totally metric group was 60% compared to 52% for the non-metric group.

Summary

The Grade 7 Assessment instruments consisted of three booklets each containing 50 content items from a total pool of 150 items. The items were grouped into fourteen objectives in seven domains. Ten of the objectives assessed content currently prescribed in the B.C. Curriculum. The remaining four objectives dealt with content not prescribed but currently being considered for inclusion in the revised version of the curriculum. Fifty-five items were repeated from the 1977 and 1981 Assessments.

In addition to the content items, each of the three individual forms included a number of different scales. Form R contained the attitude scale *Mathematics in Schools*, Form S contained the *Gender and Mathematics* scale, and Form T a scale entitled *Calculators and Computers*. A twelve-question background survey with four additional metric items was common to each booklet. All achievement items were in multiple-choice format and students marked their responses on separate scannable answer sheets. Every content item had five options of which four were possible answers and the last was "I don't know."

A total of 35 413 Grade 7 students were eligible to respond to one of the three booklets. All students in the province wrote one of the three Assessment booklets in May 1985.

Background Information

Based on the data gathered from the background information items, 91% of the students were 12 or 13 years of age at the time of the testing in May. There were slightly more boys than girls. About 89% of the students had English as a first language at home and 98% had their Mathematics taught in English.

Students have a very high regard for many school mathematics topics. Working with fractions, decimals and percents; memorizing basic facts; solving equations; and learning about the metric system all were rated important. Learning about the metric system and solving word problems appeared to be the hardest topics to learn, and solving word problems was the least enjoyable. Geometry topics were not viewed as unimportant but were regarded with disinterest by many students.

The background information showed that although calculators are not used in the classroom, close to 75% of students own them. In 1985, 27% of the students said they used a calculator in school and 34% said they used it for homework. These figures indicate an increase in calculator use since the last Assessment. Computers are present in schools and 64% of the students received most of their experience with computers through courses at school. Approximately 30% of the students have a computer at home. Students generally have positive attitudes toward computers and would like to learn more about them in the school.

The information collected on students' facility with metric units indicated that many of the students are still not using the metric system consistently but that metric usage has increased since the 1981 Assessment.

The attitude items on gender sterotyping indicated that most Grade 7 girls and boys show little stereotyping with respect to sex. The children's parents do not enjoy mathematics but think that learning mathematics is important and want their children to do well in the subject.

Achievement Results

In the Number and Operations domain, student performance was rated Satisfactory. Generally students were able to perform calculations at a Satisfactory level for whole numbers but had difficulty with fraction, decimal, and percent concepts and were not adept at estimation or checking the reasonableness of answers.

Performance in the Geometry domain was rated Marginal to Satisfactory. In the Geometric Figures and Geometric Relationships objectives, students did well on items involving simple vocabulary and two and three dimensional spatial relationships but showed weakness in the application of simple theorems and the recognition of concepts such as symmetry and congruency. The majority of items in this domain were in the Marginal to Satisfactory category which suggests that instruction in this domain should be given a much higher priority.

Results in the Measurement domain received a Marginal rating. Achievement was good on items dealing with mass, capacity, and length, but not on those items dealing with temperature, weight, and the conversion between units of mass. Many of the student responses to perimeter, area, and volume items were rated as Marginal or Weak. Students had difficulty finding the area and perimeter of a rectangle, and many were unable to find the area of a triangle. Results indicate that students appeared to have poor measurement skills, and that their performance on application or multi-stage questions was Weak.

Students performed at a Satisfactory level in the Algebra domain. Most students could correctly translate English statements into algebraic ones and substitute numbers into expressions. However, the majority of the items in the

Expressions, Equations and Inequalities objective were rated Marginal or Weak. Students had difficulty working with generalized statements and transferring basic concepts and operations to more abstract expressions. The achievement on Graphs was rated Satisfactory or better and students seemed to have good abilities in constructing and interpreting all types of graphs.

Performance on the non-curricular objectives--Probability and Statistics, Computers and Calculators--was Satisfactory. The Panel did not rate the overall objectives but instead rated individual items in the non-curricular areas. The majority of the Probability items were rated Satisfactory while most of the Statistics items were rated Marginal. Students did well with Computer Literacy and Calculator questions but many of the items in all the non-curricular objectives had high "I don't know" responses.

Results on the items in the Problem Solving domain indicated that most students have a satisfactory understanding of problems and of problem-solving skills. There needs to be a thorough outline in the curriculum guide of the many problem-solving techniques available, and students should be required to spend more time on this topic.

CHAPTER 5

GRADE 10 RESULTS

Leslie H. Dukowski *Todd Rogers*

The results of the Assessment for Grade 10 are presented and discussed in this chapter. First, the instruments used are briefly discussed. This is followed by a description of the student population including information gained from scales dealing with metric usage, the attitudes of students towards mathematics, the use of computers and calculators in school, and gender stereotyping. Finally, achievement results in each domain and objective are presented followed by a discussion of achievement by reporting category and chapter summary. Sample items have been used to exemplify points made throughout the test but space limitations do not allow every item to be presented. All percentages in the chapter have been rounded to the nearest whole percent.

The Grade 10 Interpretation Panel rated the results obtained on each item, objective, and domain using five rating categories:

Strong	ST
Very Satisfactory	VS
Satisfactory	S
Marginal	M
Weak	W

The ratings given by the Panel were based on their personal and professional opinions of the acceptability of the results. These ratings and Panel comments are given for each domain and objective.

This Assessment is the third Learning Assessment in Mathematics. In 1977 and 1981 the Assessment was conducted at the Grade 12 level, and in 1981 a representative sample of Grade 10 students was also included. Unfortunately, due to variations in sampling procedures, the results between 1981 and 1985 cannot be compared meaningfully. This difficulty is fully discussed in Chapter 2.

Description of the Instruments

As previously reported in Chapter 2, 150 achievement items were used to measure student achievement in seven domains: Number and Operation, Geometry, Measurement, Algebraic Topics, Probability and Statistics, Computers and Calculators, and Problem Solving. The domains were further divided into a total of fourteen objectives.

Of the 14 objectives tested in these domains five lie outside the prescribed curriculum in British Columbia for the tested grade levels. These objectives are Probability, Statistics, Computer Literacy, Calculator Use, and Problem Solving. Probability, Statistics, and Computer Literacy were included in the 1981 Assessment to provide baseline data. Unfortunately, because of the difficulties with sampling reported in Chapter 2, no change data will be reported in this chapter. The Computer Literacy items in 1985 are different from those in 1981; therefore, changes in achievement could not be measured. For the purposes of the Assessment, problem solving was defined as the process of finding the solution to problems which are non-standard in the sense that students would not be able to solve the problems by applying standard algorithms; they would be required to use heuristics such as drawing diagrams or finding patterns. Both the Calculator Use items and the Problem Solving items provide baseline data besides being interesting in their own right. All of this non-curricular content has been recommended for inclusion in the curriculum by groups such as the National Council of Teachers of Mathematics and the National Council of Supervisors of Mathematics. It is likely that this content will appear in the forthcoming mathematics revision for British Columbia.

The achievement items were distributed equally among three forms, R, S, and T, so that the estimated difficulties of each form were approximately equal. The booklets also contained a common set of 20 items dealing with student background information. As well, Form R contained a scale designed to provide information about students' attitudes towards mathematics in school, Form S, a scale to measure gender stereotyping, and form T, items to determine the use of calculators and computers. All items were multiple-choice and students marked their answers on answer sheets constructed specifically for the Assessment.

The student background items provided information on students' first language, type and level of mathematics courses taken currently and planned to be taken the following year, homework, socio-economic status, future plans, and reasons for studying mathematics. The *Mathematics in School* scale on form R contained 10 items, each of which required three responses. The students were asked to indicate the degree to which they thought each of ten topics stated were important, difficult, and enjoyable. The *Gender and Mathematics* scale on form S required students to indicate degree of agreement with 15 statements involving sex stereotyping in mathematics. The *Calculators and Computers* scale consisted of 8 items regarding students' use of calculators and computers in school and at home and 12 items to determine students' opinions about the uses of calculators and computers in school.

The achievement items each had five response choices. Four of the choices were possible answers and the fifth was "I don't know." Each booklet contained an equal number of items for each objective and no achievement item appeared in more than one booklet. Table 5-1 shows the distribution of items by domain and cognitive level.

Table 5-1
Grade 10: Distribution of Items

Domain	Knowledge	Comprehension	Application	Total
Number & Operation	12	10	14	36
Geometry	6	7	11	24
Measurement	5	9	7	21
Algebraic Topics	15	10	5	30
Probability & Statistics	5	6	4	15
Computers & Calculators	10	2	3	15
Problem Solving	0	0	9	9
Total	53	44	53	150

About 300 test items were developed over the summer of 1984 and were drawn from a number of sources; those made public by the National Assessment of Educational Progress (NAEP) in the United States, the 1981 Manitoba Mathematics Assessment Program, and the First, Second, and Third Secondary Mathematics Survey in the United Kingdom. Many were written specifically for the 1985 Assessment and some items, designated change items, were repeated from the 1981 Assessment.

All items were reviewed by the Advisory Committee and new or modified items were pilot tested in the Fall of 1984. Items were then chosen and distributed among the three booklets and a timing pilot test verified that the total administration time of the instruments did not exceed sixty minutes.

Description of the Population

All students enrolled in Grade 10 except those identified by school officials as unable to respond to the instruments were eligible to take part in the 1985 Assessment. A discussion of the distribution of instruments and return rates is found in Chapter 2.

Age, Sex, and First Language

The data indicate that the majority of Grade 10 students were either 14 or 15 years old: 46% and 43% respectively. About 1% were 13 years old, and 8% and 1% were 16 and 17 respectively. The number of boys and girls was almost evenly split with boys outnumbering girls by less than one percent. Of the students responding to the item regarding first language, 84% reported English as their first language, 1% French, and 15% another language. Ninety-two percent of the students indicated they spoke English in the home at that time, 1% French, and 7% another language. These data are in close agreement with the information collected in 1981.

Homework

Students were asked about the length of time that they had spent doing their last mathematics homework assignment. The responses to this item are summarized in Table 5-2 together with the corresponding summary from 1981. As shown there was close agreement between the 1981 and 1985 data. Most students spend approximately a half hour on mathematics homework.

Table 5-2
Grade 10: Homework Assignments

Length of Last Mathematics Homework Assignment	1981	1985
We don't have homework in this class	11	7
Between 1 and 10 minutes	19	19
Between 11 and 30 minutes	48	50
Between 31 and 60 minutes	17	18
More than an hour	5	6

Students were also asked to indicate how much time they spent on homework in total for all subjects the day before the Assessment test. Twenty-eight percent of the students responding replied that they had not had any homework the preceding day, 16% spent less than a half hour, 24% between a half and one hour, 21% spent between one and two hours, and 11% spent more than two hours. These data indicate that when students have homework to do, mathematics homework makes up a large proportion of the time spent.

Type of Mathematics Courses

Ninety-four percent of students responding were currently enrolled in mathematics at the Grade 10 level. Of the remainder, one percent were enrolled in mathematics at the Grade 9 or 11 level and four percent were not enrolled in any mathematics course. Items were also designed to determine the extent of semestering in Math 10. It appears from the responses that 81% of the students were enrolled in a year-long course. Twelve percent indicated that their mathematics course had started in January or February. When the 12% is combined with the 4% not currently taking mathematics this indicates that approximately 16% of the students who responded are enrolled in semestered mathematics courses in Grade 10.

Although there is only one curriculum prescribed for Math 10, many school districts and individual schools offer mathematics courses at the Grade 10 level which are commonly referred to as General Math 10 or Modified Math 10. These courses are usually designed to appeal to those students who wish to pursue careers in industry or trades that do not require completion of Algebra 11. Students were asked whether or not the Mathematics 10 course they took was designed to prepare them to take Algebra 11. Seventy-three percent of the students answered yes and 19% answered no. Seven percent of the students did not respond. These data suggest that approximately three-quarters of the students are enrolled in what is commonly referred to as Regular Math 10 or Academic Math 10.

Information was gathered regarding which mathematics courses students plan to take. The data show that 62% of the students plan to take Algebra 11 and about 28% will take Trades Math 11 or Business and Consumer Math 11. Fifty-one percent of the Grade 10 students say they plan to go on to Algebra 12. In 1981, 63% of the Grade 12 students had taken Algebra 11; however, only 38% of the population was enrolled in Algebra 12. Geometry 12 and Probability and Statistics 12, as in 1981, continue to suffer from poor enrollment. This may be because many small secondary schools do not have the enrollment required to offer such specialized courses.

Future Plans

The majority of students in Grade 10 plan to continue their education beyond secondary school. Twenty-six percent reported that they were planning to attend university and a further 26% planned to attend either a community college or other trade, vocational, or business school. Seven percent planned to take a year off and then return to school.

Of the students who were not planning to continue their education, 11% planned to enter the job market compared with

8% in 1981; 5% had other plans and 18% were undecided. There was a seven percent non-response rate. All of these data agree to a large extent with those collected in 1981.

Reasons for Studying Mathematics

Students were given the opportunity to indicate the degree of importance that they attached to various reasons for studying mathematics. They were first asked to indicate the reason they believed was the most important for studying mathematics, and then to indicate the least important reason for studying mathematics. The responses are summarized in Table 5-3.

Table 5-3
Grade 10: Reasons for Studying Mathematics

Reasons for Studying Mathematics	Most Important	Least Important
To prepare for the next year's mathematics course	14	18
To learn how to perform calculations accurately	11	4
To learn how to use mathematics to solve problems in the real world	48	6
To learn to think logically	16	16
To learn what mathematics is	3	49
No response	8	7

The largest percentage of students, 48%, believed that the most important reason for studying mathematics was to learn how to solve problems in the real world. An almost equal percentage, 49%, felt that the least important reason for studying mathematics was to learn what mathematics is. Students' preference for the study of mathematics for its applications rather than its structure should be a consideration of teachers and curriculum developers.

Metric Usage

Students were asked to respond to four items to determine the extent to which they use metric units when responding to statements about mass, temperature, distance, and capacity.

Each item took the form of a question followed by two answers: one in SI metric units and the other in Imperial units. The students were told that both answers were correct and then instructed as follows: "If you were asked each question, which one of the two answers comes to your mind first?" The questions and percentage response for each answer are presented in Table 5-4 below.

Table 5-4
Grade 10: Responses to Metric Usage Items

	Grade 10 1981	Grade 10 1985
How much does a bicycle weigh?		
About 15 kilograms	18	26
About 35 pounds	81	67
What is the temperature in this room?		
About 70 degrees	64	39
About 20 degrees	35	54
How far is it from Prince George to Prince Rupert?		
About 700 kilometres	24	30
About 450 miles	75	63
How much gasoline can the tank in a large car hold?		
About 20 gallons	81	59
About 90 litres	17	34

The data show that students' metric usage has improved over the intervening four years between Assessments but they are still not fully metricated. The question on temperature is the only one to which more than half the students responded in favour of the metric units. The same four items appeared on the booklets for Grades 4 and 7. A comparison of the responses at the three grade levels reveals that, as in 1981, students' metric usage is better in the lower grades.

Mathematics in School

Form R of the assessment booklets contained a 10-item scale entitled *Mathematics in School*. The items in the scale named topics from the junior secondary mathematics curriculum. For each topic, students were asked to indicate three things; how important they felt the topic was, how easy they found the topic, and how much they liked the topic. Students were instructed to omit responses for topics they did not recognize. The responses were made on five-point scales which ranged from "not at all important" to "very important"; "very difficult" to "very easy"; and "dislike a lot" to "like a lot". Results from these items are found in Table 5-5. The percentages reported in the table are the sums taken across the positive points of each scale: "important" and "very important," "easy" and "very easy," and "like" and "like a lot."

Table 5-5
Grade 10: Students' Attitudes toward Mathematics in School
(Percent)

Topic	Important	Easy	Like
Solving equations	82	51	49
Finding area and volume	67	53	35
Working with fractions, decimals, and percent	89	64	52
Factoring	39	54	38
Constructing geometric figures	37	47	39
Working with exponents	47	58	41
Constructing graphs	58	70	57
Estimating answers	62	64	44
Solving word problems	61	28	31
Working with congruent and similar figures	29	32	22

Taken as a whole, it appears that the aspects of school mathematics which students valued as important are those which have obvious applications in the real world: computation, solving equations, determining area and volume, solving word problems, and estimating answers. The more purely algebraic topics of working with exponents and factoring were not regarded as important by the majority of students. Topics from geometry were rated not important and unenjoyable.

When these responses are analyzed according to gender, some minor differences between males and females appear. Boys tended to rate geometrical topics more positively than girls in all three categories: importance, difficulty, and enjoyment; while girls rated algebraic and computational topics as more enjoyable. The reader should be cautioned though that the differences between males and females are relatively minor and that in no case was one gender's attitude very different from the other. Boys indicated that finding area and volume and constructing geometric figures were more important, easier, and more enjoyable than the girls indicated. The boys also found constructing graphs, solving word problems, and working with congruent and similar figures slightly easier than the girls. Girls enjoyed solving problems less than the boys. Females, however, enjoyed solving equations, working with fractions, decimals, and percent, factoring, and working with exponents more than males and find factoring and estimating answers a little easier. Girls also tended to place more importance on estimation.

Calculators and Computers

Students responding to Form T of the assessment booklets completed a scale designed to gain information about calculators and computers. The items were not exactly the same as those given in 1977 and 1981 but some indirect comparisons can be made.

Calculators

Eighty-six percent of the students indicated that they owned calculators and used them in school and outside school. While only 14% claimed to use calculators frequently at school and 5% frequently outside school, 30% claimed to use them periodically in school, and 32% outside school; 31% claimed to use them rarely in school, and 46% rarely outside school. Twenty-five percent claimed they never used calculators in school and 18% claimed they never used them outside school. In 1981, 55% of the Grade 10's said that they used calculators in school, and 65% said they used them for homework and at home. It is clear that calculator use is increasing among students, both for their studies and other applications. This continues the trend observed among Grade 12 students between 1977 and 1981.

As might be expected, calculator ownership and use increases through the higher grade levels. Whereas 91% of the Grade 4 students and 72% of the Grade 7s reported they never use a calculator in school, only 25% of the Grade 10s reported that they did not use a calculator in school. A similar trend occurred for calculator ownership and use outside school.

Students were also asked to indicate the ways in which calculators were used in mathematics class. Fifty-four percent of the students responded that they were used to calculate the answers to problems and 21% said that they were used to check answers. Only one percent of the students indicated that they were used for games and fun and 24% claimed that calculators were not allowed in mathematics class. With regard to calculator use on tests, 41% of the students said that calculators were not allowed, 37% said they were allowed on some tests, and 15% said they were allowed on all tests. Seven percent of the students said that calculators were required on some tests.

Students were also asked to give their opinions about the appropriateness of using calculators in school. Seventy-two percent of the students disagreed or strongly disagreed with the statement, "Some people say that Grade 10 students should NOT be allowed to use calculators in school;" only 9% agreed or strongly agreed. Similarly, eighty-five percent of the students disagreed with the statement, "Some people say that if students are allowed to use calculators, then it should NOT be necessary for them to learn how to add, subtract, multiply, or divide by hand;" only 7% agreed. These results indicate that students in Grade 10 believe that the calculator is a useful tool that should be employed in school, but that its use does not obviate the need for learning basic skills. The data collected from Grades 4 and 7 indicate that the younger the students were the less likely they were to indicate strong support for calculator use in school, and the more likely to agree that calculator use made learning basic skills unnecessary.

Computer Use

On the T forms at each grade level there were thirteen items about computers: three items gathered information about computer use and ten items gathered information about students' attitude toward computers. The computer use data for Grade 10 is summarized in Table 5-6.

The percentage of students who have computers at home is approximately 30% at each grade. However the percentage of students in Grade 10 who claim to never have used a computer is almost double that in Grades 4 and 7. The proportions are 22% for Grade 10 and 11% and 13% for Grades 7 and 4 respectively. Forty-six percent of the students at each grade have played games on computers and about 6% at Grades 10 and 4 write stories or letters on computers compared with 10% of the Grade 7's. Younger students have used computers more to learn about mathematics or other subjects. Eight percent of Grade 10's have done so compared with 14% of Grade 7's and 24% of Grade 4's.

About a quarter of the students at each grade received most of their experience with computers at home and half of the Grade 10 and Grade 4 students learned in courses taken at school or elsewhere. Sixty-four percent of the students in Grade 7 received most of their experience through courses at school or elsewhere.

Table 5-6
Grade 10: Computer Use
(Percent)

Item	Grade 10
Do you have a computer (one that will do more than just play games) at home?	
Yes	29
No	69
What have you used a computer to do? (Mark all that apply)	
Nothing, I've never used a computer	22
To play games	46
To write stories or letters	6
To write my own programs	18
To learn about mathematics or other subjects	8
Where did you get most of your experience with computers?	
I haven't had any experience with computers	26
At home	24
In courses taken at school or elsewhere	50

Attitudes Toward Computers

The remaining ten items related to computers measured students' attitudes toward computers. Students were asked to indicate the extent to which they agreed with each of the ten statements by using a five-point scale: Strongly Agree to Strongly Disagree. The responses are summarized in Table 5-7. For each Item the "Strongly Agree" and "Agree" percentages are combined to give the figures in the table.

The results show, in general, that students at all three grades had positive attitudes towards computers. The majority of students wanted to learn more about computers, wanted to be taught about them in school, did not feel helpless around them, and enjoyed using them. They believed that computers can be used to teach other subjects as well as mathematics, and felt very strongly that their use is appropriate for both boys and girls. As a group they appeared to be undecided about whether or not computers are exercising too much control over people's lives.

Table 5-7
Grade 10: Attitudes Toward Computers
(Percent)

Item	Agree Grade 10
I would like to learn more about computers.	77
I feel helpless around computers.	23
Every student should be taught, in school, how to use a computer.	67
Computers can be used to teach mathematics.	72
Computers can be used to teach subjects other than mathematics.	76
Using computers is more suitable for boys than for girls.	5
I feel confident about being able to use computers.	48
I enjoy using computers.	65
Computers are gaining too much control over people's lives.	37
I am able to work with computers as well as most others my age.	37

On the other hand, only 48% of the Grade 10 students claimed to feel confident about using computers compared to 63% of the Grade 7's and 69% of Grade 4's. Similarly, 37% of the Grade 10 students, compared to 54% of the Grade 7 students and 68% of Grade 4's believed that they were able to work with computers as well as others their age.

These results are consistent with those obtained in the Computer Use section reported above. Although all students reported positive attitudes toward computer use, the Grades 4 and 7 students were those who clearly appeared to have had the most confidence in their use and application.

Gender Stereotyping

The attitude scale in Form S of the booklets was entitled *Gender and Mathematics*. It contained 15 items using a five-point scale with choices ranging from "Strongly Agree" to "Strongly Disagree" which were designed to measure the degree to which students agreed with statements about sex stereotyping in mathematics. The results are summarized in

Table 5-8. The numbers in the table indicate the percentage of students who agreed or strongly agreed with each statement versus the number of students who disagreed or strongly disagreed with the statements. The results are reported separately for males and females.

Table 5-8
Grade 10: Gender and Mathematics
(Percent)

Statement	Agree/Disagree Males	Females	Total
1. Men make better scientists and engineers than women.	23/56	7/84	15/70
2. Girls have more natural ability than boys.	10/70	9/66	10/68
3. Boys need to know more mathematics than girls.	18/64	5/85	12/74
4. A woman needs a career just as much as a man does.	76/13	92/ 4	83/ 9
5. My father enjoys doing mathematics.	37/31	44/25	40/28
6. My mother enjoys doing mathematics.	25/41	29/40	27/40
7. My father is usually able to help me with my mathematics homework if I ask him to help.	48/38	48/37	48/38
8. My mother is usually able to help me with my mathematics homework if I ask her to help.	37/47	36/48	36/48
9. My mother thinks that learning math is important for me.	88/ 3	86/ 3	87/ 3
10. My father thinks that learning math is important for me.	88/ 3	85/ 3	86/ 3
11. My father wants me to do well in mathematics.	90/ 2	90/ 1	90/ 2
12. My mother wants me to do well in mathematics.	92/ 2	93/ 1	93/ 2
13. Girls can do better than boys in mathematics.	13/65	14/56	14/60
14. My mother is usually very interested in helping me with mathematics.	28/33	29/33	28/33
15. My father is usually very interested in helping me with mathematics.	36/33	40/31	38/32

The majority of students responded in non-sexist fashion to all items. However, a higher percentage of boys than girls indicated that they believed that men make better engineers than women and that boys need to learn mathematics more than girls do. A greater percentage of girls than boys indicated that they believed that women need careers just as much as men do. Nearly equal percentages of boys and girls held the same opinions regarding natural ability or expected achievement of the sexes in mathematics.

The remaining items questioned students about their parents' enjoyment of mathematics, the degree of interest and ability each parent displays in the students' mathematics homework, and the degree of importance each parent places on mathematics in students' education. There were only very slight differences between males' and females' responses to these items. The data indicated that although students tended to believe that their fathers enjoyed and were able to do mathematics more than their mothers, the differences were relatively slight: less that 15% on any pair of parallel items. Moreover, no more than 48% of the students responded that their mother or father enjoyed mathematics or was able or usually interested in helping with mathematic homework. Over 85% of the students agreed that both their mothers and fathers thought learning mathematics was important, and 90% or more agreed that each parent wanted them to do well in mathematics.

Domain 1: Number and Operation

Grade 10 is the last year in which mathematics is a required subject for all students, although this will change in 1986 with the introduction of new graduation requirements. All students are expected to pass Mathematics 10 and, among other things, have an understanding of number concepts, be able to perform calculations with whole numbers, decimals and percent, and be able to apply these skills to solve problems. The items in the Number and Operation domain were intended to evaluate these abilities. There were 12 items in each booklet covering three objectives: Number Concepts; Fractions and Decimals; and Ratio, Proportion, and Percent. The Interpretation Panel rated the student achievement on each of the items in the domain and assigned a rating to each objective and to the domain as a whole. The rating for the Number and Operation domain was Marginal. The results and ratings for the individual objectives are found in Table 5-9 and are discussed below.

Table 5-9
Grade 10: Number and Operation

Objective	Number of Items	Mean Percent Correct	Panel Rating
Number Concepts	9	48	M
Fractions and Decimals	12	61	S
Ratio, Proportion, and Percent	15	62	S
Total	36	58	M

Number Concepts

There were nine items in this objective, three on each form. They were designed to assess students' knowledge of and ability to use mathematical concepts such as place value, constructing fractions, estimation, computation with mixed operations on whole numbers, and scientific notation. The mean percent correct on this objective was 48%, a result which the Interpretation Panel rated Marginal. The ratings are summarized in Table 5-10.

Table 5-10
Interpretation Panel Ratings
Grade 10: Number Concepts

Rating	Item Numbers	Frequency
Strong		0
Very Satisfactory	S/1	1
Satisfactory	R/3, S/3	2
Marginal	R/2, S/2, T/1, T/2, T/3	5
Weak	R/1	1

The Interpretation Panel rated student performance on the item involving scientific notation as Very Satisfactory and performance on an item involving rounding as Satisfactory. Students' performance on item R/3, which assessed student ability to solve a consumer problem involving multiple arithmetic operations, was also rated Satisfactory. This item is reproduced as Figure 5-1.

R/3 A used automobile can be bought for cash for $2850, or on credit with a downpayment of $400 and $80 a month for three years. How much more would a person pay by buying on credit than by buying the car for cash?

		% of students
A.	$ 3280	11
B.	$ 640	10
C.	$ 430	55*
D.	$ 400	9
E.	I don't know	13

Figure 5-1. Grade 10--Item R/3

The items with lowest Panel ratings were those that dealt with fraction and decimal concepts and estimation. Of the results on three items dealing with fraction concepts, two were rated Marginal and one Weak. Item R/1, which had a result rated Weak, is reproduced in Figure 5-2. It required students to determine a fraction using a set-subset model. The most popular incorrect answer was to take the two numbers given in the problem and make a fraction. The correct answer required the respondent to take the sum of the two numbers and form a fraction with this sum as the denominator.

R/1 There are 13 boys and 15 girls in a group. What fraction of the group is boys?

		% of students
A.	15/28	6
B.	13/15	50
C.	15/13	6
D.	13/28	36*
E.	I don't know.	1

Figure 5-2. Grade 10--Item R/1

The three estimation items had results which were all rated Marginal. Two of the items asked students to estimate the product of three fractions or decimals; the third, was a square root estimation item. The decimal item, T/1, is reproduced in Figure 5-3. Given the widespread use of calculators in Grade 10, it is imperative that students learn to estimate so that they can check the reasonableness of answers given by the calculator.

Students' poor performance on the estimation items is a concern, as it was in 1981. The Panel suggested that estimation skills need more emphasis during teaching.

T/1 Estimate the product: 49.72 x 8.46 x 9.98 (Do not take time to perform the calculation.)

		% of students
A.	400	5
B.	4000	40*
C.	3900	24
D.	5000	23
E.	I don't know.	7

Figure 5-3. Grade 10--Item T/1

Fractions and Decimals

The 12 items in this objective were chosen to assess students' ability to compute with fractions and decimals and to apply these computations to the solution of word problems. The Panel rated performance on all but three of the items as Satisfactory or above. The mean percent correct for all items was 61%. The ratings are summarized in Table 5-11.

Table 5-11
Interpretation Panel Ratings
Grade 10: Fractions and Decimals

Rating	Item Numbers	Frequency
Strong	R/25	1
Very Satisfactory	S/15,S/17,S/26	3
Satisfactory	R/10,R/27,T/4,T/39,T/41	5
Marginal	R/26,S/16,T/40	3
Weak	-	0

The overall rating for the objective was Satisfactory. Student performance on all but one of the computation items was rated as Satisfactory or better. These items included subtracting and dividing fractions, and subtracting and dividing decimals. The one computation item result to receive a Marginal rating was Item T/40 shown in Figure 5-4. It is a decimal division in linear format. This result is surprising; when students were asked, in item T/4, to divide 0.036 by 0.12 in the "long division" format they scored much better and were assigned a Satisfactory rating. One explanation for the poor result might be that students applied the wrong algorithm to the item and counted decimal places, as for multiplication, but then moved the decimal point the wrong way to obtain the quotient. This might account for the relatively large proportion of students choosing option A.

T/40 Divide: 70 - 0.001

	% of students
A. 0.07	26
B. 700	7
C. 7 000	11
D. 70 000	44*
E. I don't know	7

Figure 5-4. Grade 10--Item T/40

Students applied fraction and decimal computation to the solution of word problems at a satisfactory level. Two such items were assigned Satisfactory ratings and the other two items were assigned Very Satisfactory ratings. One of these Very Satisfactory items, S/26, is reproduced in Figure 5-5. The result on this item is surprisingly good considering that to obtain the correct answer the student must either convert 2 1/2 to a decimal and then divide to get a decimal answer or divide fractions and convert the fraction answer to a decimal.

S/26 A marathon runner covers 42 kilometres in 2 1/2 hours. His average speed is:

	% of students
A. 8.4 km/h	11
B. 16.8 km/h	65*
C. 25.2 km/h	9
D. 33.6 km/h	3
E. I don't know.	10

Figure 5-5. Grade 10--S/26

Panel ratings on an item included to assess the skill of converting from a fraction to a decimal was given a Satisfactory rating but an item which assessed the inverse, changing from a decimal to a fraction, obtained only Marginal results. The panel also gave a Marginal rating to an item wherein students were required to choose the largest number from a list of fractions.

Skills with fraction and decimal concepts appear Weak but straight computational ability is Satisfactory. This is particularly true for those items requiring students to apply computations to the solution of word problems.

Ratio, Proportion, and Percent

The results for the third objective related to Number and Operation were rated Satisfactory. The mean percent correct of the 15 items was 62%. Panel ratings are summarized in Table 5-12. Performance on items that were strictly computational in nature tended to be rated Satisfactory. These include items such as S/27 which required students to calculate 20% of 170. Seventy-six percent of the students answered correctly and the result was rated Very Satisfactory. The Panel also rated as Strong the results of an item which required students to convert the fraction 5/6 to the equivalent percent. However, for the more difficult item which required students to change 5/12 to a percent, only 45% of the students obtained the correct answer and thus results were rated Marginal. Twenty-eight percent of students chose the option 0.41666...% rather than the correct response 41.666...%.

Table 5-12
Interpretation Panel Ratings
Grade 10: Ratio, Proportion, and Percent

Rating	Item Numbers	Frequency
Strong	R/12,S/29	2
Very Satisfactory	S/27,T/27,T/29	3
Satisfactory	S/28,S/33,T/19/T/26	4
Marginal	R/11,R/39,S/34,R/40,R/41,T/28	6
Weak	-	0

One item, R/11, reproduced in Figure 5-6 required that students determine a percentage of boys at a party given the ratio of boys to girls. Performance on the item was rated as Marginal. The most common incorrect answer was most likely obtained by simply taking the two numbers given in the problem and forming the fraction 1/2 and then converting that to a percent. This error is similar to the common error on item R/1 discussed earlier.

The Panel awarded Marginal ratings to all three of the word problems involving percent. A typical problem is R/41 which is shown in Figure 5-7. In this problem students had to calculate the amount of sales tax and add it to the cost to determine the total purchase price. Half of the students answered this question correctly and on another item 59% of the students were able to correctly determine the amount of sales tax at 5% on a car that cost $6750.00. On the third item half the students were unable to determine a salesman's total sales given the commission earned and the percent rate of commission.

R/11 At a party the ratio of boys to girls was 2 to 1. What percent of the people at the party were girls?

		% of students
A.	66 2/3%	10
B.	50%	29
C.	33 1/3%	43*
D.	200%	9
E.	I don't know	9

Figure 5-6. Grade 10--Item R/11

R/41 Linda's new bike cost $159.99 and the sales tax was 5%. How much did she pay including tax?

		% of students
A.	$164.99	11
B.	$167.99	50*
C.	$172.98	12
D.	$177.99	9
E.	I don't know	12

Figure 5-7. Grade 10--Item R/41

On the other hand students performed satisfactorily on problems involving simple ratios such as Item T/19 which is illustrated in Figure 5-8. It involved estimating the amount of gasoline needed for an extended car trip. Fifty-six percent of the students answered the item correctly and this result was rated as Satisfactory by the Panel.

T/19 John and Jean are planning a vacation trip to Winnipeg next summer. They estimate that they will drive a total of about 6500 km. Their car uses 11L/100km. Approximately how many litres of gasoline will they need for the trip?

		% of students
A.	60	7
B.	70	10
C.	600	18
D.	700	57*
E.	I don't know	8

Figure 5-8. Grade 10--Item T/19

Students achieved results rated as Weak on a ratio item involving map scale. Given a map scale and the distance on the map, students were asked to calculate the actual distance. Only 48% of the students answered correctly. This result is somewhat surprising as many of the other problems seemed much more difficult. It may be that students have a poor attitude to this particular type of problem, and therefore performed poorly.

Summary

Although the ratings for both the Fractions and Decimals objective and the Ratio, Proportion, and Percent objective were Satisfactory, the Panel felt that the rating for the entire domain should be Marginal. They commented that straight computation exercises tended to be well done but that word problems, regardless of the computational requirements, tended to be done more poorly than desired. Panel members remarked that perhaps students were not reading problems carefully and that teachers should place more emphasis on reading word problems.

Results throughout this domain indicate a weakness in estimation skills and in ratio concepts. Students also had some difficulty converting among fractions, decimals and percent but only for more complicated fractions. Students tended to do quite well on consumer-type items as long as they did not involve computations with percent. Given the importance of calculating with percent in everyday life, this is a concern.

Domain 2: Geometry

There were 24 items in the Geometry domain grouped into two objectives: Geometric Figures and Geometric Relationships. The Interpretation Panel rated the results on both objectives as Marginal. Table 5-13 summarizes the results and ratings in this domain.

Table 5-13
Grade 10: Geometry

Objective	Number of Items	Mean Percent Correct	Interpretation Panel Rating
Geometric Figures	9	47	M
Geometric Relationships	15	46	M
Total	24	47	M

Geometric Figures

The Panel ratings for the nine items in this objective are summarized in Table 5-14. Six of the items could be considered vocabulary or definition items, two of them required students to visualize an object in space or a cross section of a figure, and the last item required students to supply missing information about a rectangle. The mean percent correct for items in this objective was 47% and the overall rating was Marginal.

Table 5-14
Interpretation Panel Ratings
Grade 10: Geometric Figures

Rating	Item Numbers	Frequency
Strong	R/21	1
Very Satisfactory	T/8	1
Satisfactory	R/20,S/49,T/20	3
Marginal	R/42,S/35,S/48,T/7	4
Weak	-	0

Four of the six vocabulary items were rated as Marginal by the Panel. Sixty-four percent of the students correctly identified the diameter of a circle but only 54% could correctly identify perpendicular lines, and 48% a pair of corresponding angles formed by two parallel lines cut by a transversal. Only 23% could define the altitude of a triangle while 21% claimed not to know.

Student performance on the remaining two vocabulary items was rated as Satisfactory. Sixty percent of the students correctly identified an obtuse angle but only 18% could correctly identify the median of a triangle from a diagram and 14% claimed not to know. The most popular responses to the median item were altitude and angle bisector. The low proportion of correct responses to the median item is not surprising given the fact that the definition of median is not specifically listed as a requirement in the curriculum guide.

Students performed at a level judged to be Very Satisfactory and Strong on the two items requiring visualization of an object in space. The results on an item requiring students to determine sufficient conditions for a quadrilateral to be a rectangle were judged to be Satisfactory although only 19% of the students responded correctly. The Panel commented that this item was a very difficult item.

Geometric Relationships

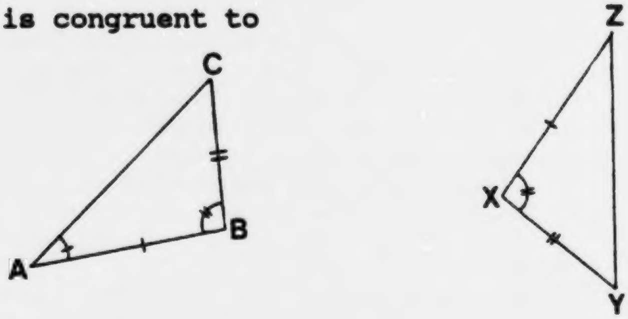
The fifteen items in this objective assessed students' knowledge and application of simple theorems and relationships among triangles, parallel lines, and angles. The mean percent correct for the items was 46% and the overall Panel rating was Marginal. Table 5-15 contains a summary of the ratings.

Table 5-15
Interpretation Panel Ratings
Grade 10: Geometric Relationships

Rating	Item Numbers	Frequency
Strong	-	0
Very Satisfactory	R/17,R/35	2
Satisfactory	R/28,R/29,S/20,S/21,T/15,T/16,T/42	7
Marginal	R/34,S/30,S/41,S/42,T/13,T/14	6
Weak	-	0

Scores on the items in this objective tended to be low but the Panel ratings for an item involving relationships among angle measures and an item about the fractional part of the area of a circle were rated as Very Satisfactory. Also rated as Satisfactory were results on items dealing with parallel lines and congruent triangles even though the two congruent triangle items were answered correctly by only 39% of the students in each case. The Panel remarked that these were very difficult questions involving material that was probably not widely taught, at least by the time of the year that the Assessment was given. For example, Item T/15, illustrated in Figure 5-9, required students to determine the correct congruence condition, SAS or ASA, and the correct correspondence between the vertices of the triangles. The triangles are rotated with respect to one another and so the correspondence was not obvious. The Panel felt that the large proportion of "I don't know" responses, 31%, supported their belief that this material had not been taught to a large number of students.

T/15 △ABC is congruent to



		% of students
A.	ZYX by SAS	9
B.	YXZ by ASA	10
C.	ZXY by SAS	39*
D.	ZXY by ASA	11
E.	I don't know	31

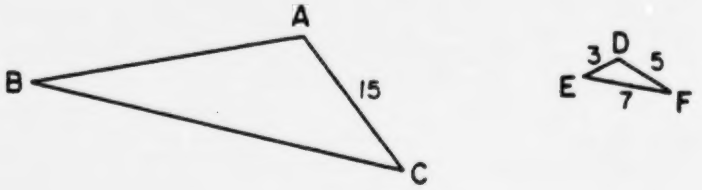
Figure 5-9. Grade 10--Item T/15

Students' achievement on two items involving parallel lines and the measures of alternate interior angles were 52% and 62%. Given the difficulty of the items, these results were judged to be Satisfactory. The "I don't know" responses for these items were 8% and 11% indicating that this content has probably been taught in more schools than congruence has.

Students had mixed achievement on the two items involving the Pythagorean theorem. Only 49% correctly responded to an item involving a straightforward application of the theorem to determine the length of a hypotenuse, and 17% used the "I don't know" option. This result was rated as Marginal. On the other hand, 46% correctly applied the theorem to the solution of a word problem while only 12% claimed not to know. This result was rated as Satisfactory.

Students' achievement was rated as Marginal on both items involving similar triangles. This Marginal achievement may be a result of lack of skill with ratio and proportion as discussed in the Ratio, Proportion, and Percent section above although at least one of the items, S/42, reproduced in Figure 5-10 was difficult because the triangles were rotated with respect to one another. To get the right answer students had to be aware that the proper correspondence among sides had to be taken into consideration. Fifty-five percent of the students chose an answer that would have been obtained if the correspondence among sides was neglected.

S/42 Triangle ABC is similar to triangle DFE. Find the length of segment BC.



		% of students
A.	21	55
B.	15	5
C.	35	21*
D.	47/5	2
E.	I don't know	11

Figure 5-10. Grade 10--Item S/42

Students' marginal performance on items involving the sum of the angle measures in a triangle was disappointing to the Panel in that they thought that knowledge of this theorem is basic. Students did however receive a Satisfactory rating on an item which required them to determine the measure of the interior angle of a regular hexagon. This problem, the Panel felt was not a trivial one, and a 40% correct response rate was adequate. Forty-three percent of the students were able to find the perimeter of a hexagon formed with six equilateral triangles. Again, given the novel nature of the question, this result was considered Satisfactory.

Summary

Both objectives as well as the geometry domain as a whole received a Marginal rating. Students' performance on half of the items commonly considered standard junior secondary geometry was rated as Marginal. It would appear that the teaching of Geometry has not improved since the 1981 Assessment and is being neglected in favour of Algebraic content. Geometry must receive more emphasis in the classroom, perhaps by reviewing the expectations for student mastery of algebraic content in Grades 9 and 10.

Domain 3: Measurement

The Measurement domain consisted of 21 items: 6 items in the Metric Units objective and 15 in the objective titled Perimeter, Area, and Volume. Interpretation Panel members rated student performance on the two objectives and the domain as a whole as Satisfactory. The achievement results and ratings are summarized in Table 5-16.

Table 5-16
Grade 10: Measurement

Objective	Number of Items	Mean Percent Correct	Interpretation Panel Rating
Metric Units	6	69	S
Perimeter, Area, & Volume	15	50	S
Total	24	55	S

Metric Units

Table 5-17
Interpretation Panel Ratings
Grade 10: Metric Units

Rating	Item Numbers	Frequency
Strong	-	0
Very Satisfactory	R/22,S/31,S/32,T/43	4
Satisfactory	-	0
Marginal	R/18,T/21	2
Weak	-	0

The mean percent correct on this objective was 69% and this result was rated Very Satisfactory. The two items rated as Marginal were those dealing with the conversion of grams to kilograms. The other four items required that students convert 5 metres to centimetres, estimate temperature on a hot day, estimate the mass of a young boy, and estimate the length of a crayon. These results are consistent with the results of the *Metric Usage* scale in the background items in the booklets. Students were better able to use metric units for length and temperature than for mass or capacity. The Interpretation Panel ratings for individual items in this objective are summarized in Table 5-17.

Perimeter, Area, and Volume

The results on the 15 items in this objective were mixed, and somewhat puzzling. Panel ratings ranged from one Strong to one Weak with the rest of the ratings distributed fairly uniformly as shown in Table 5-18. The mean percent correct was 50%. Students attained marginal results on items for which one would have expected fairly good scores and yet they scored well on items related to other items in the Assessment for which performance was rated as Marginal.

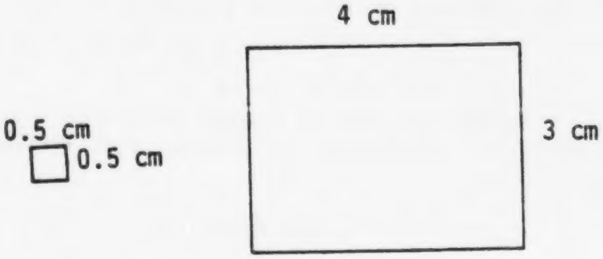
Table 5-18
Interpretation Panel Ratings
Grade 10: Perimeter, Area, and Volume

Rating	Item Numbers	Frequency
Strong	R/7	1
Very Satisfactory	R/9,S/4,S/5	3
Satisfactory	R/36,S/6,T/22,T/23,T/44	5
Marginal	R/8,R/19,S/24,S/25,T/5	5
Weak	T/6	1

Students' performance was rated Satisfactory on two items where they had to determine the number of square units which would fit inside a quadrilateral. For example on Item S/5, shown in Figure 5-11, 57% of the students correctly determined that 48 squares 0.5 cm on a side would fit inside a 4 cm by 3 cm rectangle. Students' performance was also rated Satisfactory on an item requiring them to find the area of a compound rectangular figure and to determine the number of litres of paint required to paint a rectangular surface. These results are surprising given that the students generally did not do well on questions involving straightforward applications of the formulas for areas and perimeters of rectangles. Only 70% correctly calculated the perimeter of a rectangle when the length and the width were specified; twenty percent multiplied the two values and 6% added the two. Only 40% of the respondents could find the area of a square given the perimeter and this performance was rated as Marginal by the Panel, as were the results of an item on finding the area of a right triangle.

Seventy-six percent of students correctly found the volume of a rectangular solid, an achievement rated Very Satisfactory; but only 39% could correctly estimate the volume of a rectangular solid. This item, S/25, is illustrated in Figure 5-12. The majority of students could not determine the relationship between circle radius and area. Only 13% correctly answered that if the radius of a circle was doubled then the area was made four times as large. This is consistent with the results of an item on estimating the area of a circle given its radius of 5 m; thirty-four percent correctly answered the item and 17% chose the "I don't know" option.

S/5 How many of the squares will fit into the rectangle?

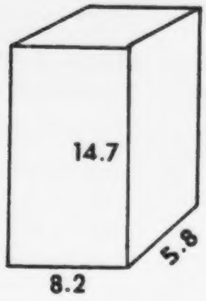


		% of students
A.	6	2
B.	12	10
C.	24	27
D.	48	57*
E.	I don't know	3

Figure 5-11. Grade 10--Item S/5

Perhaps the most surprising, however, was the Very Satisfactory performance on an item which required finding the length of the shortest side of an isosceles triangle given the perimeter and the length of one of the equal sides. Seventy percent answered correctly; yet on the item involving isosceles triangles in the Geometrical Relationships objective, only 46% chose the correct response, a Marginal result.

S/25 The best estimate for the volume of the solid shown below is:



		% of students
A.	29	10
B.	56	10
C.	550	25
D.	720	39*
E.	I don't know	15

Figure 5-12. Grade 10--Item S/25

Summary

Except for the items involving conversion from grams to kilograms, students seemed to have a good grasp of metric units and concepts but showed some weaknesses in their knowledge of formulas and in their ability to estimate. The Panel pointed out that the curriculum guide emphasizes calculating areas, perimeters, and volumes given the formula whereas the Assessment items required that students have them memorized. Panel members suggested that teachers be reminded to expect students to memorize the formulas for perimeter and areas of triangles, rectangles, and circles and the volumes of rectangular solids.

Domain 4: Algebraic Topics

Two objectives, Expressions, Equations, and Inequalities, and Graphs made up the Algebraic Topics domain. There were 21 items in the first objective and 9 in the second. A summary of Panel ratings is given in Table 5-19.

Table 5-19
Grade 10: Algebraic Topics

Objective	Number of Items	Mean Percent Correct	Interpretation Panel Rating
Expressions, Equations, & Inequalities	21	48	M
Graphs	9	60	S
Total	30	52	M

Expressions, Equations, and Inequalities

Items in this objective assessed students' knowledge and skill in writing, evaluating, and simplifying expressions, solving equations, and interpreting algebraic expressions. The mean percent correct was 48% and performance on the items was rated as Marginal overall. Table 5-20 summarizes the item ratings for this objective.

Table 5-20
Interpretation Panel Ratings
Grade 10: Expressions, Equations, and Inequalities

Rating	Item Numbers	Frequency
Strong	-	0
Very Satisfactory	S/40,T/17,T/30,T/37	4
Satisfactory	R/37,R/38,S/37,S/38,S/39,S/47, T/31,T/32	8
Marginal	R/45,R/46,R/47,R/48,R/49	5
	S/45,S/46,T/36,T/38	4

Students received two Satisfactory and one Weak rating on the three items involving evaluating and simplifying expressions, and one Weak and one Satisfactory rating on the two simplifying items. Students had difficulty simplifying the expression $r + s - (r - s)$. Only 25% selected the correct response.

Two items required that students work with the simple interest formula, and on both of the items the achievement was rated as Marginal. For example, on item R/45 which is illustrated in Figure 5-13 only 41% could correctly calculate the simple interest on a $1000 investment. Fifteen percent chose the "I don't know" option. On a related item, finding the principal given the interest and the rate, only 31% answered the question correctly and 25% claimed not to know.

R/45 The formula used to calculate simple interest is $i = Prt$ where i is the interest, P is the principal, r is the rate, and t is the time in years.

Using the formula shown above, find the interest on a principal of $1000 invested for two years at an annual rate of 7%

		% of students
A.	$140	41*
B.	$1400	16
C.	$70	11
D.	$14	6
E.	I don't know	15

Figure 5-13. Grade 10--Item R/45

Five items assessed student performance solving equations. Results were rated Weak on two items and Marginal on two items. Only the simplest of the five equations produced results that were rated Very Satisfactory.

Forty-seven percent of students were able to give the roots of a quadratic equation in factored form, and 54% correctly factored a simple quadratic trinomial. Both these results were judged to be Satisfactory.

Two items required that students predict the effect of varying the value of one of the variables in an algebraic expression. Achievement on both these items was rated as Satisfactory. Performance on the four items in which students had to translate English phrases to algebraic expressions received one Marginal rating, one Satisfactory rating and two Very Satisfactory ratings.

Graphs

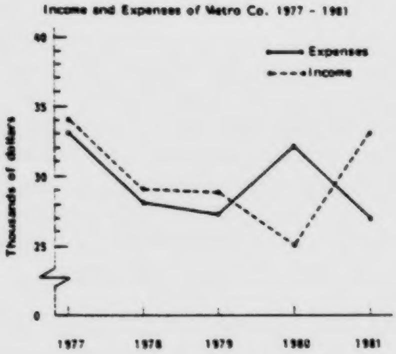
The Panel rated students' performance on the Graphs objective as Satisfactory overall. Student performance on three of the nine items was judged to be Very Satisfactory, four Satisfactory, and two Marginal. The objective measured students' ability to interpret graphs, find the slope of a line, find the coordinates of a point, and construct graphs. Ratings for individual items are summarized in Table 5-21.

Table 5-21
Interpretation Panel Ratings
Grade 10: Graphs

Rating	Item Numbers	Frequency
Strong		0
Very Satisfactory	R/16, R/23, S/10	3
Satisfactory	S/18, S/19, T/18, T/47	4
Marginal	R/15, T/24	2
Weak		0

For the three items selected to measure students' ability to interpret graphs, the achievement was rated Very Satisfactory. Figure 5-14 shows Item R/23 which is typical of this type of item.

R/23 According to the graph below, in which year did the Metro Company make the largest dollar amount of profit?



		% of students
A.	1978	3
B.	1979	4
C.	1980	12
D.	1981	77*
E.	I don't know	3

Figure 5-14. Grade 10--Item R/23

Four items assessed students' ability to construct graphs. One item involving bar graphs and a second involving a broken-line graph produced Satisfactory performance results. The results of a third item which required students to choose the correct graph given an equation were rated Marginal.

Over three-quarters of the students could correctly identify the coordinates of a point, however, and this achievement was considered Satisfactory as was the performance on an item that required students to find the area of a rectangular figure given the coordinates of the vertices. Thirty percent of the students answered this item correctly.

Summary

The Panel was generally disappointed with the level of achievement on items in the Algebraic Topics domain given its emphasis in the Grade 9 and 10 curriculum. They suggested that a reorganization of the curriculum throughout the junior secondary grades was required, particularly to give emphasis to topics such as the solution of linear equations and the application of consumer formulas.

The study of algebra typically takes up the majority of time in Mathematics 10 classes. The Panel indicated that, in some classes, the quantity of algebra taught forces the study of geometry and other topics to the end of the year when there is not enough time to cover them adequately. In addition algebra is studied in far more depth than is indicated by the core curriculum in the curriculum guide.

Domain 5: Probability and Statistics

Probability and Statistics are not included as part of the prescribed content in the present curriculum. However, both have been recommended for inclusion by professional organizations of mathematics educators and are receiving more emphasis in curricula being developed in other provinces and countries. They were included as objectives in the 1981 Assessment to provide baseline data so that student performance on these new topics can be monitored when they are introduced into the B. C. curriculum. In 1981 it was thought that the new curriculum would be in place by 1985. The Interpretation Panel ratings and achievement levels for the fifteen items in this domain are summarized in Table 5-22.

Table 5-22
Grade 10: Probability and Statistics

Objective	Number of Items	Mean Percent Correct	Interpretation Panel Rating
Probability	6	54	S
Statistics	9	33	S
Total	15	41	S

Probability

Knowledge of Probability was assessed by six items which had a mean percent correct of 54%. The performance on all of these items was rated as Satisfactory or higher. The ratings are summarized in Table 5-23.

Table 5-23
Interpretation Panel Ratings
Grade 10: Probability

Rating	Item Numbers	Frequency
Strong	R/24	1
Very Satisfactory	T/9	1
Satisfactory	R/50,S/7,S/11,T/25	4
Marginal	-	0
Weak	-	0

Five of the items assessed students' ability to determine the probabilities of chance events. Item T/9, reproduced in Figure 5-15, illustrates this type of item. Results on the other four items of this type show similar response patterns. In no case was the "I don't know" response more than 7% of the total.

> T/9 For a party game each number shown below was painted on a different Ping Pong ball, and the balls were thoroughly mixed up in a bowl. If a ball is picked from the bowl by a blindfolded person, what is the probability that the ball will have a 4 on it?
>
> 2, 3, 4, 4, 5, 6, 8, 8, 9, 10

		% of students
A.	1/2	3
B.	1/4	10
C.	1/5	59*
D.	1/10	21
E.	I don't know	5

Figure 5-15. Grade 10--Item R/23

The remaining item called for students to tell how many different ways there were to paint a car in two colours if one was allowed to use combinations of any 2 colours out of five. Only 28% of the students responded correctly, but the Panel thought that because the question was not of a type commonly seen in mathematics classes, and that the question may have been difficult to understand, that this proportion represented a Satisfactory level of performance.

Statistics

The ability to interpret statistical information is becoming increasingly important in all aspects of daily life. At present there is only one formal course in this subject, Probability and Statistics 12. As with Probability, many authorities are calling for a greater emphasis on this topic at all levels of mathematics education. Statistics was also included as an objective on the 1981 Assessment. The nine statistics items were chosen to determine students' ability to interpret information presented in tabular form and to test their facility with the three measures of central tendency, the mean, the median, and the mode. The overall Panel rating for the somewhat disappointing performance in this objective was a reserved Satisfactory given that the content is not part of the prescribed course of study up to Grade 10. The individual item ratings are summarized in Table 5-24.

Table 5-24
Interpretation Panel Ratings
Grade 10: Statistics

Rating	Item Numbers	Frequency
Strong	-	0
Very Satisfactory	T/45	1
Satisfactory	R/4,S/9,T/48	3
Marginal	R/32,R/33,S/36,T/10	4
Weak	S/8	1

Students did not perform well on the five items involving reading and selecting information from a table. The Panel rated achievement as Very Satisfactory on one item where students were required to read a bank statement and state the balance in an account; all other item ratings were Marginal. One of these items asked students to determine the total tax payable on a given income using a tax table, 42% did so correctly. The other three items were similar to Item R/33 which is found in Figure 5-16. Only 33% of the students answered the question correctly. Eighty-one percent found the proper entry in the table of information but less than half of that proportion realized that the entry represented seven hundred passengers rather than just seven.

R/33 How many passengers used the Fiske airport in June?

AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers Per Month Jan.	Feb.	Mar.	Apr.	May	Jun.	Total
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

	% of students
A. 7	48
B. 26	8
C. 700	33*
D. 2600	6
E. I don't know	2

Figure 5-16. Grade 10--Item R/33

Four items assessed students' knowledge of mean, median, and mode. No more than 27% of the students answered any of these items correctly and in each case between 28% and 40% of the students responded "I don't know". Item S/8 is illustrative of these and is reproduced as Figure 5-17.

S/8 The mean of the set of numbers (2, 2, 2, 3, 4, 5, 10) is

	% of students
A. 3	10
B. 2	30
C. 10	8
D. 4	21*
E. I don't know	31

Figure 5-17. Grade 10--Item S/8

Because median and mode are not curricular topics, the results on items involving these terms were rated as Satisfactory. However,Item S/8 assessed students' knowledge of mean. Panel members thought that students should have been exposed to this term and therefore should have had higher achievement than the 21% correct response rate. The rating given was Weak.

Summary

Students generally attained low scores on items in this domain but, as the content is not specified in the core curriculum, the Panel felt that a Satisfactory rating was appropriate. However the interpretation of statistical data is becoming increasingly important in the real world. Polls are conducted and the findings used as justification for public policy and the actions of companies in the private sector. Therefore Probability and Statistics should be implemented in the curriculum revision.

Domain 6: Calculators and Computers

Two non-curricular objectives, Computer Literacy and Calculator Use, were included on the 1985 Assessment. Items in these objectives were designed to assess students' knowledge of the use and operation of calculators and computers. Because the content is non-curricular, the Interpretation Panel assigned Satisfactory ratings to both objectives. As shown in Table 5-25.

Table 5-25
Grade 10: Calculators and Computers

Objective	Number of Items	Mean Percent Correct	Interpretation Panel Rating
Computer Literacy	6	40	S
Calculator Use	9	48	S
Total	15	45	S

Computer Literacy

The six items whose Panel ratings are given in Table 5-26 which made up this objective were substantially different from those given in 1981. Whereas at that time the items were intended to measure students' knowledge about the capabilities, applications, and impact of computers on society, the 1985 items were largely concerned with providing baseline data about students' ability to interpret the meaning or effect of a list of procedures or instructions, and their ability to translate algebraic expressions to symbols commonly used in computer languages. Only one item required students to define any computer vocabulary and on that item 78%

correctly identified a "program" as a list of instructions for a computer. This result was rated as Strong.

Table 5-26
Interpretation Panel Ratings
Grade 10: Computer Literacy

Rating	Item Numbers	Frequency
Strong	R/30, T/35	2
Very Satisfactory		0
Satisfactory	R/31, S/12, S/44, T/11	4
Marginal		0
Weak		0

R/31 An imaginary computer has commands called PRAX and ADDO

PRAX does the following: Print out the value of X
Do the command called ADDO

ADDO does the following: Add 2 to the current value of X
Do the command called PRAX

What will the following set of instructions do?

X = 2
PRAX

		% of students
A.	print out the odd numbers greater than 0	2
B.	print out all integers greater than 2	16
C.	print out the even number greater than 0	31*
D.	print out all the integers less than 2	6
E.	I don't know.	42

Figure 5-18. Grade 10--Item R/31

Three items assessed students' ability to follow a list of instructions much as a computer would when performing a procedure. Performance on one was rated as Strong and on the other two as Satisfactory. Item R/31 illustrates this type of item and is shown in Figure 5-18. Thirty-one percent of the students correctly answered this item. That performance was considered to be Satisfactory considering the difficulty of the question. A large number of students, 42%, chose the "I don't know" option. This was the highest such rate of all three questions and is not surprising given the novelty of the question. On one of the other items 73% of the students chose the correct "LOGO-like" procedural instructions to complete drawing a figure with only 10% responding "I don't know". The third item contained a numbered list of instructions for arranging a list of names. Only 15% of the students answered correctly, but 55% chose the most reasonable incorrect alternative indicating some partial success with the item; only 9% chose "I don't know."

Two items tested students' ability to interpret algebraic expressions when written using common computer symbols. On both items the most frequent option choice was "I don't know," but both had results rated as Satisfactory given that such content is non-curricular. The low percentage of correct responses is somewhat surprising. Many of the newer mathematics texts often make use of these symbols and a large number of students claimed to have used computers. It would be natural to expect that students would be able to interpret and use these symbols.

Calculator Use

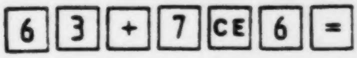
Performances on four of the nine items in this objective were rated as Very Satisfactory, and five of the item results were rated as Satisfactory. The ratings are summarized in Table 5-27. Seven of them required students to interpret the action of a keystroke or a sequence of keystrokes. Item S/23, shown in Figure 5-19 is an illustration of this type of item. It appears that some students may have not been aware of the effect of the CE key and thought that, instead of the keystroke having the effect of erasing only the last entry shown on the display, it erased the entire sequence of keystrokes.

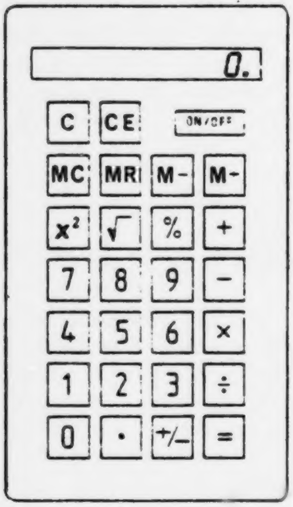
Table 5-27
Interpretation Panel Ratings
Grade 10: Calculator Use

Rating	Item Numbers	Frequency
Strong		0
Very Satisfactory	R13, S22, T33, T46	4
Satisfactory	R6, R14, S23, S43, T34	5
Marginal		0
Weak		0

The only two items of these seven where "I don't know" response rates were higher than 6% were on the item shown above and on one other item which gave a sequence of 8 keystrokes including adding, subtracting and recalling from memory and taking a square root. The proportion of correct responses was 23% and 37% of respondents said they didn't know. It appears that students believe that they can use calculators as long as the keystroke combinations are not long or complicated.

S/23 The following sequence of keystrokes is carried out on the calculator:





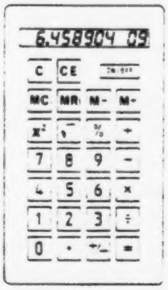
What will likely be shown in the display?

		% of students
A.	6.	47
B.	69.	25*
C.	76.	10
D.	636.	3
E.	I don't know	14

Figure 5-19. Grade 10--Item S/23

One would expect that students would make the most use of calculators for computations with numbers that were particularly large or small. Often when one performs such calculations, the number is too long to display in decimal form on the display. It is therefore shown in scientific notation. Item T/34, which is seen in Figure 5-20, was used to determine whether or not students could correctly read a number displayed in this fashion. Only 17% of the students knew what the calculator was displaying, even though they were told the factors which had been multiplied to give the displayed number. Only 19% of the students chose the "I don't know" response which indicates that 61% of the students thought they knew what was meant but in fact did not. The Panel rated this as a Satisfactory result given that the item was non-curricular.

T/34 Someone has just multiplied 6540 by 987 600 on the hand calculator. The calculator with the answer displayed is shown on the right.



The product of the two numbers is

		% of students
A.	6 458 904 000	17*
B.	6 458 904 009	15
C.	6.458904^9	41
D.	645 890 400	5
E.	I don't know	19

Figure 5-20. Grade 10--Item T/34

Summary

The Panel ratings on each objective and the domain as a whole were Satisfactory given that computer studies are not a part of the prescribed curriculum and that the level of computer instruction varies widely among schools. Also calculator use is not usually formally taught and the questions used in the Assessment may have been difficult for some students to understand. The Panel commented, however, that there is a need for a K-12 computer curriculum and that calculator use and abuse should be part of a unit in Grade 9. The calculator unit should also be taught with an emphasis on estimation and students should be encouraged to gain experience with different types of calculators.

Domain 7: Problem Solving

For the purposes of this Assessment a student would be engaged in problem solving if he or she were faced with a novel situation where the possibility of a solution is recognized but standard algorithms or procedures cannot be guaranteed to produce a solution. The problem solver must then use general strategies, or heuristics, such as looking for patterns, examining extreme cases, or trial and error to solve the problem. This type of problem solving, although currently recommended by educators as appropriate for teaching in mathematics, may not generally be emphasized in Mathematics 10. Usually problem solving at this level consists of translating a given word problem into an appropriate algebraic form and then manipulating the resulting expressions to arrive at an answer. Although the application of algebraic skills is a powerful tool, it is not the only problem-solving tool.

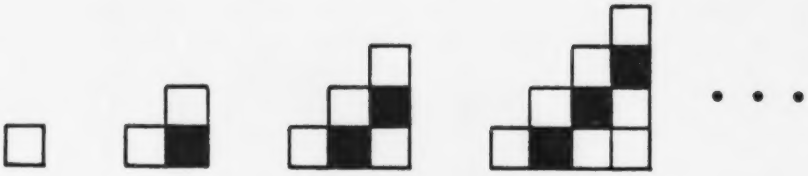
None of the nine items in this domain lent themselves to the application of a standard algorithm or procedure normally taught to secondary students. Therefore each of the items presented students with a problem that could be solved only by the application of more general problem-solving strategies. The mean percent correct for the nine items in the domain was 42% and performance was rated Satisfactory overall. A summary of the Panel ratings is given in Table 5-28. The Panel felt that ratings on item results in this domain should be lenient as non-standard problem solving is not what is normally taught.

Table 5-28
Grade 10: Problem Solving

Rating	Item Numbers	Frequency
Strong		0
Very Satisfactory	R/43,T/12	2
Satisfactory	R/44, S/14, S/50, T/49, T/50	5
Marginal	R/5,S/13	2
Weak		0

Four of the items required, as a possible strategy, looking for patterns. Results on all these items were judged to be Satisfactory although scores on some of the items were quite low. Item T/50 is illustrated in Figure 5-21 and is an example of an item of this type.

T/50 How many white squares will there be in the 10th figure in the following pattern?



		% of students
A.	45	18
B.	46	26*
C.	55	20
D.	512	7
E.	I don't know	21

Figure 5-21. Grade 10--Item T/50

A possible strategy for the solution of various types of logic puzzles is to construct a table to summarize the information given and then examine cases. A logic item of this type, R/43, elicited 46% correct responses, an achievement that was judged to be Very Satisfactory.

Two problems had results that received Marginal ratings. One problem is fairly easily solved if a diagram is drawn. A 4x4x4 cube is painted blue and then cut into 64 unit cubes. Students were asked to determine the number of smaller cubes with paint on exactly one face. Only 28% could correctly determine the solution and 17% claimed to not know.

The other item with Marginal results is R/5 which is reproduced in Figure 5-22 and which required students to find how many numbers have digits with a sum of five if 0 is not used. The problem can be solved by examining cases and making an organized list. Eleven percent of the students answered correctly; 32% chose the "I don't know" option.

Students' performance on the problem-solving item was not strong although most students tried to solve the problems. For all but two of the nine items less than 20% of the students chose the "I don't know" option. The Panel commented that some of the difficulty students experienced with the items might have been due in part to poor reading. There is also no prescribed Problem Solving curriculum. Performance was rated as Satisfactory overall, however, given that the items in this domain do not reflect what is usually taught as problem solving in Mathematics 10.

R/5 The numbers 111, 21, 12, and 3 are all the whole numbers whose digits have a sum of 3. Zero is not used. How many numbers are there that have digits that add up to 5?

		% of students
A.	6	25
B.	8	13
C.	15	18
D.	16	11*
E.	I don't know.	32

Figure 5-22. Grade 10--Item R/5

Reporting Categories

Students' achievement in mathematics is the result of a great many factors. However, in a report of this length it is not possible to explore the relationship among all factors of interest to mathematics educators, nor is it possible to report on even a very few in great depth. In the section that follows, student achievement in relation to gender, program, first language, and homework are discussed briefly. No attempt is made to form a cause and effect relationship; the Assessment was not designed for that purpose. Although interesting trends may be evident, it remains for follow-up studies to seek causal relationships.

Sex Differences

The results of the Assessment support previous studies on sex-differences in Mathematics. This body of literature indicates that, starting in about Grade 8, boys outperform girls in all areas of mathematics except for computation and related skills.

As shown in Figure 5-23 males outperformed females on all domains except Domain 4: Algebraic Topics where performance levels were equal. An examination of the individual objective scores shows that males outperformed females on all objectives except 1.2 Fractions and Decimals and 4.1 Expressions, Equations, and Inequalities. The differences, while reliable, are relatively slight; only the scores on Domain 3: Measurement, and Domain 6: Computer Literacy, differ by more than 5%. These data are summarized in Figure 5-23. Given the differences in achievement associated with other factors, the differences associated with gender are minor.

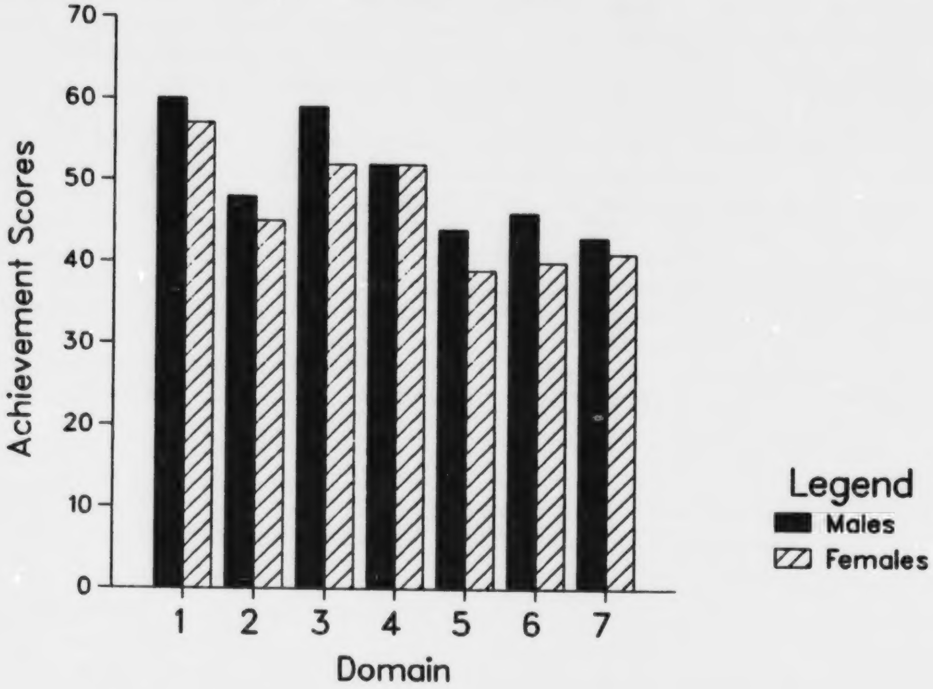


Figure 5-23. Grade 10--Achievement by Sex.

First Language

All three of the Assessments have included items which gathered information about students' first language learned. The data from the current, 1985, Assessment show that overall performance is approximately equal between students from an English-speaking background compared with students from non-English speaking backgrounds. Students with a non-English background perform slightly better on the Algebraic Topics Domain and slightly more poorly on the Probability and Statistics and the Problem Solving Domains. These observations are consistent with those made in 1981.

Regular and General Mathematics Courses

Although there is only one Mathematics course prescribed in the junior secondary grades, in practice almost all schools have more than one course of studies in mathematics for students enrolled in Grades 9 and 10. These courses are usually referred to as Regular or Academic Math and General or Modified Math. It is the usual practice to enroll those students wishing to take Algebra 11 in the Regular course and those students who do not require Algebra 11 in the General course. The Regular course tends to contain a great deal of algebra, far above that required in the core sections of the curriculum guide. The General course, on the other hand may contain less Algebra than that specified in the guide. Therefore one would expect differences in achievement between the two groups of students on the Assessment items.

The data in Table 5-29 show quite clearly that the students in the General classes do very much more poorly than the students in the Regular classes. This is true in all domains not only in the Algebraic Topics Domain but also the other domains, notably the Number and Operation Domain. The results are particularly disappointing considering that nearly all the items in the curricular objectives of the Assessment are marked as core topics. It seems that the Modified or General Mathematics classes are not having the desired effect of improving the competence of lower ability students in the basic curriculum.

Table 5-29
Grade 10: Achievement Results by Program

Program	Domain						
	1	2	3	4	5	6	7
"Regular" Math 10 (leads to Alg 11)	63	50	59	57	44	45	45
"General" Math 10	41	32	40	32	32	34	31
Total	58	47	55	52	41	45	42

Homework

Students who reported having been assigned Mathematics homework scored higher on all domains than those students who reported having no homework assigned. It is interesting to note the decline in performance as the time spent on homework exceeded 30 minutes. Perhaps this is accounted for by less able students requiring more time to complete assigned work. The results are displayed in Figure 5-24.

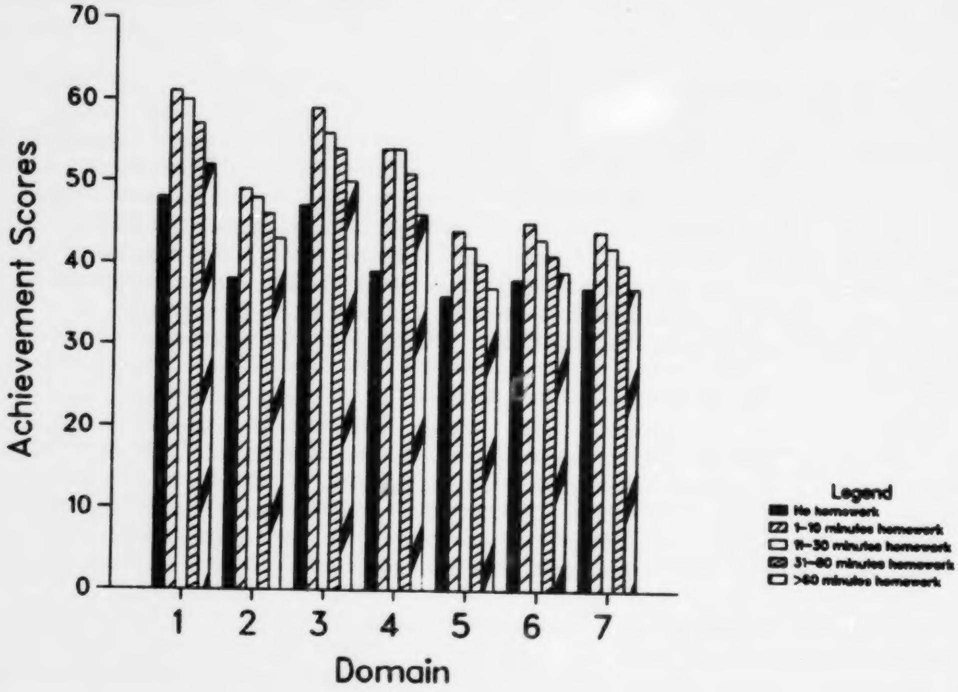


Figure 5-28. Grade 10--Achievement by time spent on homework.

Semestered Courses

Students were asked to indicate when the course they were currently taking began. The 18 349 students who reported that their course started in September were assumed to be enrolled in a whole year course; the 2735 who reported that the course had started in January or February were assumed to be enrolled in a semestered course. Students in whole year courses performed slightly better on all domains except Domain 6: Calculators and Computers. The difference in achievement on each domain was three percent or less. Because the Assessment was administered before the end of the year, the differences may be due to the fact that semestered students, who could be receiving mathematics more frequently each week, had not finished as much of the course as non-semestered students.

Summary

The Grade 10 Assessment instruments consisted of three booklets each containing 50 achievement items from a pool of 150 items grouped into fourteen objectives in seven domains. Nine of the objectives assessed content currently prescribed in the British Columbia Curriculum. The remaining five objectives dealt with content not currently prescribed but which may be considered for inclusion in future British Columbia curricula.

Background Information

Based on the data gathered from the Background Information items, 89% of the students responding were either 14 or 15 years old and almost evenly split between boys and girls with boys slightly outnumbering girls. Eighty-four percent had English as a first language and 92% spoke English in the home. Two percent of the students were enrolled in each of the Early and Late French Immersion programs and one-half percent of the students attended *Programme Cadre de Français*.

Ninety-four percent of the students were currently enrolled in a Grade 10 mathematics class; approximately three-quarters in a course designed to prepare them for Algebra 11. Eighty-one percent of the students were enrolled in a non-semestered course. Ninety-three percent of the students were assigned homework in mathematics class.

Students indicated that the most important reason for studying mathematics is to learn how to solve problems in the real world. The least important reasons was to learn about mathematics itself.

The responses to the *Metric Usage* items show that although the majority of students did not choose to use metric measures for mass, length, or capacity, slightly more than half chose Celsius over Fahrenheit for a measure of temperature. In addition, the proportion of students choosing the metric measures increased over the period between 1981 and 1985.

Responses to the *Mathematics in School* scale indicate that students felt that working with fractions, decimals, and percent and solving equations were the most important topics in school mathematics. Working with congruent and similar figures, factoring, and working with exponents were the least important topics. It appears that those aspects of school mathematics which have the most obvious applications to the solution of real world problems are those which students valued as important. These topics, with the exception of word problems, were not viewed as particularly difficult or unenjoyable.

Most Grade 10 students owned calculators and used them both in and out of school. Grade 10's also believed that calculators are a useful tool that should be employed in school. Twenty-nine percent of the students also owned a computer but few students had used the computer extensively in school. Students also expressed generally positive attitudes towards computers and most said that they would like to learn more about them.

The majority of males and females responded in a non-sexist fashion to the items in the Gender and Mathematics scale. Girls, however, had a higher proportion of non-sexist responses than boys on those items which gathered information about careers. There were not substantial differences between boys and girls on the responses to other items.

Achievement

The 150 achievement items were distributed equally among the Assessment booklets by objective. The items each had five answer options, the last of which was "I don't know".

Number and Operation. The Interpretation Panel rated the results of the Number and Operation Domain as Marginal. The items involving straightforward computations tended to be well done but performance on word problems, regardless of the computational requirements, was not generally satisfactory. Results throughout the domain indicate a weakness in estimation skills and ratio concepts. Students tended to do quite well on consumer-type items as long as they did not involve computations with percents.

Geometry. As a whole, performance in the Geometry Domain was rated as Marginal. Students had difficulty with some elementary vocabulary items but showed good ability to reason about objects in space. Many students appeared not to know the results of some of the elementary theorems in geometry such as the Vertical Angle Theorem and theorems having to do with the sum of the angles in a triangle, parallel lines, and congruence conditions. Also, students did not do well on items involving similar triangles.

The Panel commented that even though in many schools the geometry section of the course was left until the end of the year, at the time the Assessment was conducted or later, instruction in geometry was probably neglected in favour of algebra, and that more emphasis should be placed on the teaching of geometry. This call for more emphasis on geometry is in accord with sentiments expressed in the 1981 Assessment as well.

Measurement. The achievement on items in the Measurement Domain was rated as Satisfactory overall. Students showed a good grasp of estimating in metric units, but found it difficult to convert between grams and kilograms. There was mixed achievement on items involving perimeter, area, and volume. Students appeared to have a fairly good grasp of area concepts but had difficulty with the straightforward computation of perimeters and areas. They also had difficulty estimating areas and volumes. Students did do well, however, on a consumer type item and a difficult item involving calculating the shortest side of an isosceles triangle given its perimeter.

Algebraic Topics. Student performance on the Expressions, Equations, and Inequalities Objective was rated Marginal and performance on the Graphs Objective was rated Satisfactory. Performance on the domain as a whole was rated as Marginal. Achievement on two items involving the simple interest formula was rated as Weak and students had difficulty solving all but the simplest equations. Student performance on interpreting the effect of varying the value and variable in an algebraic expression and translating English phrases to algebraic expressions was generally rated as Satisfactory. Satisfactory ratings were also given to results on items which required students to interpret and construct consumer graphs. However, achievement was rated Weak on one item that required students to find the slope of a line and another which required students to choose the correct graph of a linear equation in two variables.

Probability and Statistics. The results on the two objectives in this domain were rated as Satisfactory. As the content in the domain is non-curricular, it is not surprising that the proportion of correct responses on some items is low and that on some items there was a high incidence of the "I don't know" option. The students showed some intuition for elementary concepts of probability but did not do well on items that required careful reading of tables or computation of mean, median, and mode. It is probable that students were not familiar with these measures of central tendency, or at least the vocabulary.

Calculators and Computers. Achievement on the items in this domain were rated as Satisfactory overall given that the content is non-curricular. The somewhat low performance on the items in the domain, however, indicates that students are not altogether facile with the use of calculators.

Problem Solving. The items in this domain presented students with non-routine problems which could not be solved through the simple application of a previously learned algorithm. A Satisfactory rating was given to the results in this domain even though many students could not solve the problems. There were a great many "I don't know" responses to items in this domain.

Reporting Categories

The data was analyzed according to a number of different reporting categories. As in 1981, boys outscored girls on the Assessment as a whole. In fact, boys' achievement was marginally higher than girls' on all domains except Algebraic Topics where the scores were the same. In no case did the difference between sexes exceed 7% on any domain. The differences associated with sex, although reliable, are minor.

Students whose first language is not English scored about the same as those students whose mother tongue is English on all domains. As could be expected, students enrolled in a General, or Modified, Mathematics course scored much more poorly than those students enrolled in the Regular, or Academic course which prepares students for Algebra 11. Students taking Mathematics 10 on a semestered basis scored slightly lower than those taking the course year-round. Also, students who are assigned homework scored better on every domain compared to those students who claimed not to have any homework assigned.

CHAPTER 6

ALTERNATE TEST FORMS

Alan Taylor *Thomas O'Shea*

At each grade level, two booklets consisting of open-ended items were administered to a 4% sample of the provincial population of students. These so-called Q-Forms were inserted into every 25th position among the R, S, and T forms when packages of booklets were assembled by ERIBC. Instructions to teachers and administrators stressed the importance of retaining this order when the booklets were distributed in each class.

The purpose of the Q-Forms was to gain insight into the processes used by students in a variety of mathematical situations and problems. Each form addressed a different range of questions including the interpretation, analysis, and approach to problem solving; the use of measuring instruments; and the understanding of basic algebraic concepts.

Description of the Instruments

Two forms, designated Q-1 and Q-2, were designed for each grade level. Each form contained a set of background questions, three multiple-choice test items, and a series of open-ended achievement items. All six forms are included as Appendix K of this report.

The design and focus of the Q-1 Forms differed at each grade level. At Grade 4, students were given two distinct types of items. In the first type they were presented with two numbers connected by an operation, for example, 28 x 84, and they were asked to write a story to show how the number combination might be used. In the second type, a story problem was presented, and students were directed to select the correct combination of number and operation. At the Grade 7 level, students were provided with a ruler and protractor with which they were asked to measure lengths and angles, and to draw a number of geometric figures. Questions at the Grade 10 level focussed on students' understanding of algebraic concepts and operations.

The Q-2 Forms were designed with a common format across grades and focussed on computation and problem solving. Each form contained a set of computational items which corresponded to a set of word problems involving equivalent operations. A third set of items was of a more complex nature in which students were required to apply their knowledge in unfamiliar problem-solving situations.

Marking Procedures

A team of three graduate students in the Mathematics and Science Education Department at the University of British Columbia marked the Q-Forms during the months of June and July, 1985 under the supervision of members of the Contract Team. They recorded a great deal of information about each item, including the methods students used to arrive at correct answers to computational items, and the strategies they employed in problem solving. For incorrect responses, they noted error types and patterns as well as variations in the interpretation of problems and algorithms.

Once the categories of information had been determined, the team developed and refined a detailed key for each form. Each person marked a third of the total number of Q-Forms at each grade level. To monitor marking procedures and establish reliable interpretation of student responses, approximately 10% of the forms were marked twice, with each of those papers being re-marked by another marker. Results were recorded on separate marking sheets so that neither member of a marking pair had prior knowledge of how her counterpart had rated the items. A tally was kept of discrepant ratings, and the proportion of these averaged 5% among the different forms, resulting in an inter-rater reliability index of about 0.95 for each form. The markers also discussed each item of disagreement and reached consensus as to the correct coding.

The Q-Form Samples

Analysis of the information from the Q-Forms was carried out on a total of 1519 students who wrote the Q-1 Forms and 1454 who wrote the Q-2 Forms. The details of the sample by grade and sex are shown in Table 6-1. The total for each grade level does not equal the sum of the males and females because some students did not indicate gender.

Table 6-1
Q-Form Sample

	Grade 4			Grade 7			Grade 10		
Form	M	F	Total	M	F	Total	M	F	Total
Q1	286	236	552	260	266	542	206	207	425
Q2	252	245	530	269	233	532	176	208	392

To obtain some measure of the representativeness of the Q-Form samples, the first three multiple-choice achievement items from Form R at Grades 4 and 10, and from Form S at Grade 7, were included in the same format at the beginning of the achievement section of each respective Q-Form. Comparisons between performances on these items by students in the Q-Form samples and the R,S,T Form populations are reported in Table 6-2

Table 6-2
Responses To Multiple-Choice Items By Form
(Percent Correct)

Form	Grade 4			Grade 7			Grade 10		
	Item No.			Item No.			Item No.		
	1	2	3	1	2	3	1	2	3
Q-1	95	85	88	83	92	97	41	54	70
Q-2	93	84	87	82	91	95	45	54	72
R or S	89	70	70	71	82	90	35	39	55

Students in the Q-Form sample achieved significantly higher results at each grade level than the R or S populations. Differences in p-values ranged from 4 to 18 percentage points at the Grade 4 level, 5 to 12 at the Grade 7 level, and 6 to 17 at the Grade 10 level. The mean p-value differences at successive grade levels were 12, 9, and 13, respectively.

Further information on the Q-Form samples was obtained by including two items at the Grade 10 level which asked students whether their current mathematics course prepared them for Algebra 11, and which mathematics course they planned to take in Grade 11. Eighty-three percent on each Q-Form stated that their mathematics course was designed to prepare them for Grade 11, in comparison to 73% who gave the same answer to a similar question on the R, S, and T Forms. Seventy-six percent of the respondents listed Algebra 11 as the course they planned to take in Grade 11 as compared to 62% in the population of students.

Final evidence as to the nature of the samples was obtained from the Q-2 Forms in which a number of multiple-choice items from the R, S, and T forms were re-organized into an open-ended format. At each grade level students in the Q-Form sample consistently outperformed students writing the R, S, and T forms. That is, Q-sample performance on open-ended items exceeded the population performance on the same items in multiple-choice format. This result is contrary to research findings which indicate that multiple-choice is the easier of the two formats.

Based on this information, it can be concluded that a select group of students at each grade level wrote the Q-Forms. It is likely that the order of booklets was altered in some cases when they were distributed to students. As a result, comparisons between items which appeared in open-ended format on the Q-Forms and multiple-choice format on the R, S, and T Forms will be of limited interest. However, the strategies that students used to answer questions and the types of errors they made remain important findings. Conclusions as to the overall level of performance of students on the open-ended items should be treated with caution.

Background Information

The first three items in the background section were the same at all grade levels on Form Q-2 and at Grade 4 on Form Q-1. They asked students to identify their gender, to indicate how well they felt they did in mathematics, and to list the most important reasons for studying mathematics.

The item which asked students how well they felt they performed in mathematics contained five options, ranging from "very well" to "poor". For purposes of reporting, the scale has been collapsed into three categories: above average, average, and below average, and results are shown in Table 6-3.

Table 6-3
Self Perception of Mathematical Ability
(Percent)

Rating	Grade 4 Q1 & Q2	Grade 7 Q2	Grade 10 Q2
Above average	60	55	11
Average	36	38	47
Below average	4	7	42

These data show that Grades 4 and 7 students have a far higher perception of how well they perform in mathematics than those in Grade 10. For example, 60% in Grade 4 and 55% in Grade 7 feel they are above average compared to only 11% in Grade 10. This result is confirmed at the other end of the scale where, at successive grade levels 4, 7, and 42 percent of the students feel they are below average. These results appear to indicate a less optimistic attitude on the part of older students.

On another background question students were asked the most important reasons for studying mathematics. The question was in open-ended format, and responses were classified into the following categories: job oriented, life skills, prerequisite for further study, logic or problem solving, enjoyment or aesthetics, to learn mathematics, and other. Up to three reasons were accepted from each student, and the results are shown in Table 6-4. The "To learn mathematics" category was added after marking the Grade 10 Q-2 Forms, because it seemed that some students emphasized the word "studying" rather than looking at the reason for learning mathematics. That is, one has to spend time studying the subject in order to learn it.

Table 6-4
Most Important Reasons For Studying Mathematics
(Percent)

Reason	Grade 4		Grade 7		Grade 10	
	Q1	Q2	Q1	Q2	Q1	Q2
Job oriented	32	27	54	51	39	42
Life skills	27	31	51	47	54	53
Needed for further study	3	4	8	10	12	15
Logic or problem solving	5	4	7	7	15	20
Enjoyment or aesthetics	2	1	1	1	1	2
To learn mathematics	30	25	16	16	19	--
Other	5	3	5	5	4	8
No Response	9	12	9	9	7	7

Students value mathematics for the preparation they believe it gives them for life skills and for the job market. Two areas that were given increased emphasis at successive grade levels were mathematics for logical reasoning or problem solving, and mathematics as a prerequisite for further study. Almost no one listed enjoyment as an important reason for studying mathematics.

Q-1 Form: Grade 4

Form Q-1 at the Grade 4 level was designed to assess students' understanding of the four basic number operations. Students were asked to identify the operations needed to solve a number of word problems, and they were asked to write a story to illustrate each of a set of formal computations. The form was based on one used in a British study of children's understanding of mathematics (Hart, 1980, 1981), in which results were reported for a sample of approximately 500 11-year-old children. Because about 90% of Grade 4 students in British Columbia are 9 or 10 years old, comparisons with the performance of students in England may reasonably be drawn. The wording in several of the items was changed to place the problems in a British Columbia context, and several new items were added.

Part 1: Generating Story Problems

In the first section of the booklet, students were presented with seven combinations of numbers and operations and asked to write a short story to tell how each combination might be used. The number combinations were designed to test students' knowledge of the four basic operations, and consisted of one item on addition, and two items each on subtraction, multiplication, and division: 28 + 84,13 - 7, 84 - 28, 9 x 3, 84 x 28, 9 ÷ 3, 84 ÷ 28. Results are presented here for each of the operations in turn. The classification of models that students used for each operation is based on that presented in Hart (1981). All examples have been transcribed without editing from the students' booklets.

Addition. On the one addition item, 28 + 84, 96% of students generated an appropriate story. Seventy-nine percent used the *adding-on* model, and this high percentage may have been influenced by the fact that the example given to begin the section demonstrated the same model for the sum of 5 and 2. A typical response of this type was: "Mike had 28 packs of hockey cards he played with his friends with hockey cards he won 84 more cards How much does he have altogether?" Seventeen percent used the *union* model, for example: "In a bus there are 28 boys and there are 84 girls how many children are in the bus?"

For the union model the order of the numbers is not of great importance; however, in adding-on, the first named number should be the one to which the second is added. Seventy percent of the students kept the order as presented, whereas 26% reversed the order.

Subtraction. The results on the two subtraction items are shown in Table 6-5.

The dominant model used by students was that of *take away*. A typical example would be: "Lucy had 84 dolls 28 got wrecked. How many dolls does Lucy have? The answer is 56." Other models were used more frequently on the item involving larger numbers, and this item was slightly more difficult than the one with smaller numbers.

Table 6-5
Subtraction Models
(Percent of Students)

Model	Item 13 - 7	Item 84 - 28
Correct		
Take away	95	88
Comparison	1	2
Complementary addition		
(i) union	1	3
(ii) addition	1	1
Incorrect	2	5
No response	-	1

In the *comparison* model two similar entities are compared: "Michael had 28 marbles. Phillip had 84 marbles. How many dose Michael have then Phillip?" The two *complementary addition* models are derived from the two basic approaches to addition: union ("There was 84 kids on the team 28 girls. How many boys?"), and adding on ("Kristy had 28 dollars. She needed 84 to buy a attari. How much more money did she need.")

In the British study, only 77 percent of 11-year-olds were able to supply a satisfactory story problem for 84 - 28. In that study the children "almost always gave a straight 'take away' model" (Hart, 1981, p. 30).

Multiplication. The results for the two multiplication items are shown in Table 6-6.

In the *rate* model the two numbers are used in the sense of "*x* at the rate of *y* per *x*". For example: "Jack had 9 bags of marbles with 3 in each bag. How many marbles does Jack have?", or for a more complex example: "Percy had 84 feathers. Each of 28 cousins gave 84 more feathers to Percy each. Now how many feathers does Percy have?". This proved to be the most popular model selected by the students, and is in line with the usual textbook model where *a* x *b* is thought of as "*a* groups of *b* in each".

When one number is used as a *multiplying factor*,that is, "times as many", the result is something like:"Ernie had 84 stickers Eric had 28 times as much. How many stickers does Eric have?" The third model, *area/array*,is similar to the first but the examples are clearly of a row-by-column nature. For example: "There was a car lot it had 84 rows of cars 28 cars in each. How many altogether?" The use of each of the first three models was consistent across the two items, indicating that the size of the numbers was irrelevant to the applicability of each model.

Table 6-6
Multiplication Models
(Percent of Students)

Model	Item 9 x 3	 84 x 28
Correct		
Rate	39	37
Multiplying factor	14	14
Area/array	6	6
Repeated addition	10	-
Incorrect	29	34
No response	2	9

Repeated addition was used only with the combination having small numbers, for example: "Mike had 9 candies. The next day he bought 9 more and the day after that 9 more how many did he buy in 3 days?" Students who used this model tended to think of the situation as 3 groups of 9. Of the 50 students who used repeated addition for 9 x 3, 40% were incorrect on 84 x 28, whereas 42% correctly shifted to a rate model, and 16% to a multiplying factor.

While the overall usage rates were similar for each of the first three correct models, students shifted models as they grappled with different number combinations. From the results in Table 6-7 it may be concluded that the area/array model is the most versatile because proportionately more students using this model than the other two were able to shift to a correct model for the second problem.

Overall, 58% of students were successful on both items, 18% on one, and 24% on neither. In the British study only 45% of the 11-year-olds successfully generated a correct problem for 9 x 3, and only 31% did so for 84 x 28 (Dickson, Brown & Gibson, 1984, p. 232).

The incorrect responses were analyzed for misinterpretations of the problems. Of the 158 incorrect responses to 9 x 3, 90 students wrote a story using addition. Of the 186 incorrect responses to 28 x 84, 71 students showed an addition story.

Table 6-7
Consistency of Use of Multiplication Models

		Model Used for 84 x 28				
		Mult. Factor	Rate	Area/Array	Incorrect	Total
Model Used for 9 x 3	Mult. Factor	50 (70%)	11 (16%)	1 (1%)	9 (13%)	70
	Rate	13 (6%)	149 (73%)	7 (3%)	34 (17%)	203
	Area/ Array	1 (3%)	12 (34%)	19 (54%)	3 (9%)	35
	Incorrect	6 (4%)	13 (9%)	3 (2%)	120 (85%)	142

Some students avoided interpretation by embedding the item in a question, for example: "Nicky was playing on her chalkboard she was learning times question she wrote one on the board. It was 9 x 3. What is the answer?" Such a response was classified as incorrect. For 9 x 3, 24 students, and for 28 x 84, 45 students attempted this ruse.

Students were split on their interpretation of the proper order of numbers. For 9 x 3, 42% used the numbers as given, while 34% used the reverse order. For 28 x 84, the proportions were 62 and 28 percent.

Division. The results for the two division items are shown in Table 6-8.

A typical response for the *sharing* model was: "There were 9 cupcakes in the cupcake sale, 3 people came. How many will each get if they split all 9 up into 3s?" In the *grouping* model the emphasis is on how many groups the collection can be separated into: "The grade 4 class was going to go pickup litter, but only 9 kids could come. Katrina decided to divided them in groups of 3. How many groups are there?" A typical response for *repeated subtraction* shows the sequential removal of groups of objects from a collection: "There were 9 children at the birthday party. Each hour 3 children went home. How many hours did it take for all 9 children to go home?" The *dividing factor* response is similar to that for the multiplying factor: "Shane had 28 hockey cards his brother had 84 hockey cards haw many more X the cards he had to catch up to his brother."

Table 6-8
Division Models
(Percent of Students)

Model	Item	
	9 ÷ 3	84 ÷ 28
Correct		
Sharing	47	37
Grouping	15	20
Repeated subtraction	1	1
Dividing factor	-	1
Incorrect	32	30
No response	5	11

The success rate for providing division stories was about the same as for multiplication. The sharing model appears to be less appropriate when dealing with larger numbers. As with multiplication, students changed models across the two items, as shown in Table 6-9. In general, 58% of the students correctly responded to both items, and 25% responded correctly to neither.

The error analysis showed that about half the students who were incorrect on 9 ÷ 3 chose a subtraction combination, and about one-third on 84 ÷ 28 did the same. As was the case for multiplication, many students embedded the item in a question, and this accounted for about 15% of the inappropriate responses in each case.

In the British study 60% of the 11-year-olds were successful with 9 ÷ 3 and 42% with 84 ÷ 28. In British Columbia those figures for Grade 4 students were 63 and 59 percent, respectively.

Table 6-9
Consistency of Use of Division Models

		Model Used for 84 28			
		Sharing	Grouping	Incorrect	Total
Model Used for 9 3	Sharing	172 (70%)	42 (17%)	31 (13%)	246
	Grouping	15 (20%)	49 (64%)	13 (17%)	77
	Incorrect	17 (11%)	19 (12%)	119 (76%)	156

Summary. Each child was assigned a total score on the seven items. The mean for the 552 students was 5.4, the median was 6, and 38% of the students scored 7 out of 7. The results indicate that Grade 4 students in British Columbia are quite adept at producing appropriate word problems. Their performance is even more encouraging when compared with that of 11-year-olds in Britain.

Part 2: Selecting Appropriate Number Combinations

In the second part of the booklet, students were given a series of word problems and they were asked to show how they would work out each problem. To do this they had to circle the operation of their choice from a list of eight. There were ten problems in all: one in addition, and three each in subtraction, multiplication, and division. A sample problem in addition was given to start the section.

Each item is reproduced in this section and the percentage of students who selected each response is shown in parentheses. The non-response rate was 2% for each item.

Addition. The addition problem shown in Figure 6-1 used a measurement model which, because it included directed distances, has been called *vector subtraction*. It has been suggested that this type of addition is the most difficult of all for young students (Dickson et al., 1984, p. 225), and, in fact, this item did prove to be the most difficult of the ten in this section.

In the British study, 74% of 11-year-olds selected a correct response on this item. The item was constructed using numbers for measurement rather than for counting, and students in British Columbia seldom showed such usage in part one of the booklet. The superior performance of British students may indicate that they are exposed to a wider range of variables in learning basic operations.

12. The signpost shows that it is 29 km west to Grange and 58 km east to Barton. How do you work out how many kilometres it is from Grange to Barton?

29 + 58 (52)	58 ÷ 29 (1)
58 - 29 (17)	29 x 2 (15)
29 ÷ 58 (5)	58 + 29 (1)
58 x 29 (4)	87 - 29 (2)

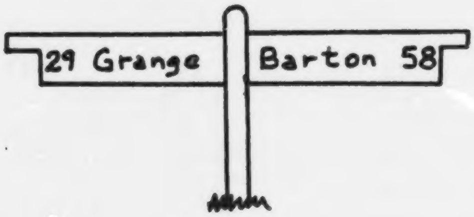


Figure 6-1. Addition problem (vector subtraction).

Subtraction. Of the three subtraction items, Items 13 and 16 dealt with the distance remaining after travelling a certain distance on a trip. These differed only in the magnitude of the numbers involved. Item 20 was a simple problem in comparative subtraction. Results on the three items are shown in Figure 6-2.

13. John is cycling 8 km home from school. He stops to rest after 2 km. How do you work out how much farther John has to go?

8 + 2 (5)	2 x 4 (2)
2 ÷ 8 (3)	8 - 2 (69)
8 x 2 (2)	2 + 6 (2)
2 - 8 (8)	8 ÷ 2 (8)

16. The Klassen family have to drive 261 km. to get from Victoria to Campbell River. After driving 87 km they stop for lunch. How do you work out how far they still have to drive?

87 x 3 (1)	261 + 87 (3)
87 ÷ 261 (5)	261 - 87 (70)
261 x 87 (3)	261 ÷ 87 (9)
87 - 261 (7)	87 + 174 (2)

20. Pat has 9 stickers. Fran has 17. How do you work out how many more stickers Pat needs to have the same number as Fran?

17 ÷ 9 (6)	17 + 9 (3)
9 x 2 (1)	9 x 17 (-)
17 - 9 (77)	9 ÷ 17 (2)
9 - 17 (5)	9 + 17 (5)

Figure 6-2. Subtraction items.

About 70% of students selected the correct procedure, regardless of the model and the magnitude of the numbers. On all three items the next most popular, and incorrect, choice consisted of the correct numbers, in the correct order, but separated by a division symbol. This may indicate confusion over symbols, rather than incorrect choice of operation. This possibility is reinforced by the fact that, in the first section of the booklet, the most common misinterpretation of a number combination involving the division symbol was subtraction. Students' third choice of procedure was subtraction with the digits reversed, for example, 2 - 8. Here again, the problem may be that students read the combination 2 - 8 as "2 from 8". Comparison with the British study shows such apparent reversals to be much greater among British students than those in British Columbia.

To assess the consistency of students' use of the more plausible incorrect procedures, a cross-tabulation of responses to Items 13 and 16 was carried out. Approximately half the students who chose an incorrect subtraction or division procedure on Item 13 (i.e., 2 - 8, 2 ÷ 8, 8 ÷ 2) chose the same incorrect procedure on Item 16 (i.e.,87 - 261, 87 ÷ 261, 261 ÷ 87). Thus, a small group of students, about 9% of the total, consistently chose an incorrect response. On the other hand, 62% of the students correctly responded to both items.

A cross-tabulation of sex by response patterns to all items was carried out. The only items to yield significant variations from chance were on the three subtraction items (p=.06, p=.02, p=.02, respectively). In each case the deviant pattern centred on number reversals, with a higher than expected proportion of boys choosing the reverse order. One might expect this pattern to be replicated on the division problems, but this was not the case, and it is difficult to explain the clearly evident gender difference on the subtraction items.

Multiplication. Two multiplication items were rate problems. Item 15 involved small numbers and dealt with measurement using a continuous variable. Item 19 used larger numbers and dealt with a discrete variable. The third item, Item 17, was a combinatorial type. Results for the three items are shown in Figure 6-3.

There were two correct responses for each item, and they were selected by a total of about 70% of the students. Students tended to choose the number combination which listed the numbers in the order in which they appeared in the word problem. For example, the proper interpretation of Item 15 would be 4 x 8, that is, 4 buckets of water, each containing 8 litres, but most students chose 8 x 4. On the two items with larger numbers, the most popular incorrect choice was to add them. On Item 15, this was not the case, perhaps because the word "emptied" evoked the more popular subtraction choice.

In the British study, the correct response rates were much more varied: Item 15, 80%; Item 17, 46%; Item 19, 66%. The superior performance of British Columbia students on the combinatorial problem may indicate that they are being exposed to a wider variety of models for multiplication than their British counterparts.

15. A bucket holds 8 litres of water. 4 buckets of water are emptied into a tub. How do you work out how many litres of water are in the tub?	8 x 4 (56) 12 − 8 (1) 8 + 4 (8) 4 + 4 (1)	4 ÷ 8 (1) 8 ÷ 4 (5) 4 x 8 (15) 8 − 4 (12)
19. A tray used for baking muffins will hold 56 muffins. A baker fills 28 trays. How do you work out how many muffins he bakes?	56 ÷ 28 (10) 28 ÷ 56 (3) 56 + 28 (12) 28 x 56 (26)	84 − 28 (1) 56 x 28 (41) 56 + 56 (-) 56 − 28 (4)
17. A shop makes sandwiches. You can choose from 3 kinds of bread and 6 kinds of filling. How do you work out how many kinds of sandwiches you could choose?	3 x 6 (49) 6 + 3 (19) 18 ÷ 3 (2) 6 x 3 (19)	6 − 3 (3) 3 − 6 (1) 6 ÷ 3 (5) 3 + 3 (1)

Figure 6-3. Multiplication items.

A cross-tabulation of responses to Items 15 and 19 showed that 55% of the students selected correct responses to both items, while 19% gave incorrect responses to both. Thus the ratio of students who do not understand multiplication to those who clearly do is a fairly high 1 to 3, which may indicate that the concept of multiplication needs to be stressed at this grade level.

Division. Two division problems, Items 11 and 14, used a grouping model, the difference between the two being the magnitude of the numbers. The third item, Item 12, used larger numbers in a sharing application. The items and results are shown in Figure 6-4.

In each grouping problem, 52% of the students responded correctly, and 62% were correct on the sharing problem. However, if one assumes that children interpret a division symbol in a way which requires the smaller to be divided into the larger--for example, 3 ÷ 12 means "3 goes into 12"--then the acceptable response rates increase to 59, 71, and 75 percent. There is a third alternative, and that is the equivalent multiplication problem. Students found this particularly attractive on Item 11 in which very small numbers were used: i.e., 3 x 4. If this approach is deemed acceptable, the success rates become 72, 73, and 77 percent.

British Columbia students consistently outperformed their British counterparts by about 20 percentage points in selecting the correct response. When the other two responses are accepted, performance is about the same, indicating again that British Columbia students have less trouble with reversals than the British students.

11. A bar of chocolate can be broken into 12 squares. There are 3 squares in a row. How do you work out how many rows there are?	12 + 3 (4) 12 x 3 (17) 6 + 6 (2) 12 - 3 (4)	3 x 4 (13) 3 - 12 (-) 12 ÷ 3 (52) 3 ÷ 12 (7)
14. 286 people are coming to see the school play. The chairs are arranged in rows, and there are 26 chairs in each. How do you work out how many rows are needed?	26 x 286 (15) 26 ÷ 286 (19) 26 + 286 (6) 26 - 286 (2)	26 + 26 (-) 286 - 26 (3) 26 x 11 (2) 286 ÷ 26 (52)
18. A gardener has 391 daffodils. These are to be planted in 23 flowerbeds. Each flowerbed has the same number of daffodils. How do you work out how many daffodils will be planted in each flowerbed?	391 - 23 (6) 23 - 391 (1) 391 + 23 (2) 23 x 17 (2)	23 ÷ 391 (13) 391 x 23 (8) 23 + 23 (1) 391 ÷ 23 (62)

Figure 6-4. Division items.

A cross-tabulation of responses to Items 11 and 14 showed that 39% of the students chose the single correct response to both items, and 55% were correct on both items under the more liberal criteria. On the other hand, 14% answered neither item correctly using the liberal interpretation; 26%, using the strict interpretation.

To assess the persistence of the error of reversing the digits, responses to Items 14 and 18 were cross tabulated. Of the 101 students who chose 26 ÷ 286, 44 also chose 27 ÷ 391. This is 8% of the total sample, and indicates a sizable group which may have a basic misinterpretation of the division symbol.

Summary

Each student was assigned a score out of ten for this section. The median score was 7, and the mean was 6.5 with a standard deviation of 2.8. The students performed reasonably well, but there was an appreciable variation in their achievement. The order of increasing difficulty of the operations appears to be subtraction, multiplication, and division, and this is as might be expected given the order in which these operations are introduced in the British Columbia curriculum.

A comparison of the results on the two sections shows that students were more successful in creating problems for subtraction and division than they were in deciding to use these operations to solve a given problem. On the other hand, they were less successful in generating word problems for the multiplication operation than they were in identifying multiplication as the correct procedure to solve a given problem.

Q-1 Form: Grade 7

Form Q-1 at the Grade 7 level was designed to assess the facility with which students could use a ruler and protractor. Each student was provided with a double-scale protractor and a 15 cm ruler, which was also graduated in inches.

The items were designed to lead the students through increasingly complex measurements. In dealing with lengths, students were asked to determine the length of a given line segment, to determine the distance between two points, to determine the length of a given rectangle, to draw a segment of a given length, and finally to determine the radius of a given circle. In working with angles, students were asked to measure an acute angle opening right, to measure an acute angle opening left, to measure an acute angle in a given triangle where an extension of one side was required, to measure an obtuse angle in a pentagon where an extension of at least one side was required, to draw an angle of a given measure, and to draw a right angle. Two of the final three items required students to integrate the use of the two instruments to construct polygons: a square with sides of 4 cm, and a triangle with sides of 5 cm. One item required a knowledge of measurement, multiplication, and rounding to determine the area of a given rectangle.

Background Information

Two background items were unique to this form. One asked what activities using ruler and protractor students had done in school during the year. Twenty percent of the students listed three activities, 50% listed two, and 82% mentioned just one. The activities mentioned by students were: to measure distances (46%), to measure angles (43%), to draw angles (15%), to draw polygons (7%), in other subjects, e.g., science (6%), for geometric constructions (4%), other (11%), undeterminable, e.g, "geometry" (23%), none (9%), and no response (8%).

In the 1978 Curriculum Guide, there are several core objectives which require the use of ruler or protractor, specifically: use compass and straight edge to copy an angle, bisect an angle, and bisect a segment; use a ruler to measure length in metric units; and use a protractor to measure angles. Students' self-reported use of the two instruments indicates that fewer than half the students had participated in such activities during the year.

In a second background item students were asked to list the geometry instruments they owned. The instruments, with the percentage of students owning each, were: ruler (93%), protractor (90%), compass (79%), 45-45-90 triangle (70%), 30-60-90 triangle (66%), and other (11%). From these results it is apparent that about two-thirds of the students own at least a geometry set. Some of the other instruments listed were: dividers, T-square, "roller ruler", stencil, 360-degree protractor, and "instrument for measuring position of stars from the earth".

Use of Ruler

The first six items of the booklet assessed students' facility with a ruler. In the first item students were presented with a line segment, XY, which was between 8.2 and 8.3 cm in length, and they were asked to determine the length to the nearest centimetre. The results are shown in Table 6-10.

Table 6-10
Length of a Given Segment

Response	Examples	Percent
Correct	8, 8cm, 8cm., 8c.m.	87
To nearest mm	8.3cm, 8.3, 8.2, 8.4	4
Rounded up	9, 9cm, 9cm.	3
To half cm	8.5 cm	2
Other	83cm, 4inch, 9.12cm	4

The most gratifying result on this item was that only four students gave an answer in inches. Students were able to recognize and correctly use centimetres as units of measurement. The results also indicate that the great majority of students were able to round to the correct value in centimetres. The occasional oddity occurred, for example, 9.12 cm is the distance between the centres of the letters X and Y which were the labels for the endpoints of the segment.

On the second item students were asked to determine the distance between two points, A and B, in millimetres. The distance was between 96 and 97 mm. Because the rulers supplied by the manufacturer were not consistent in the accuracy of the markings, answers of 96 or 97 were deemed acceptable. Results are shown in Table 6-11.

Table 6-11
Distance Between Two Points

Response	Examples	Percent
Correct	96, 97mm, 97mi, 96mm., mm97	62
Correct, in cm	9.6cm, 9cm 7mm, 9.6cms	6
Incorrect units	9.6mm, 9.6mi, 96cm	2
Nearest cm	10cm, 100mm, 100mi, 100ce	11
Close	95mm, 9.8cm, 9.75cm	7
Inches	4m, 4mm, 40mm	2
Other		10

The results on this item reveal a good deal of confusion as to the correct unit, as well as the correct symbol for the unit. The correct answer was given by only 62% of the students, although, if some flexibility is allowed in reporting the units, about 70% carried out the measurement correctly. The difficulty of this item compared to the previous one can only be attributed to the difference in the unit of measurement. It should be noted that there were 91 distinct responses to this item. Eighteen percent of the students converted this item into one equivalent to the previous item by drawing in the segment connecting the end points, A and B.

On the next item students were asked to "determine the length of rectangle MNPQ, to the nearest millimetre". The dimensions of the given rectangle were 71 mm by 31 mm. Values of 71 or 72 mm were accepted as correct; 31 or 32 mm if students chose to measure the shorter side. Results are indicated in Table 6-12.

These results were entirely unexpected. Almost half the students, as far as can be determined from examining the nearly 150 different kinds of responses, interpreted the length of the rectangle to mean its perimeter. A few even chose to calculate the area. A small group assumed the shorter side to be the length. The results suggest that teachers should indicate clearly what each term refers to when discussing geometric figures.

On the other hand, measuring the perimeter of the rectangle was much more difficult than measuring the length. For success on this task a range of 204 to 208 mm was accepted, and about 68 percent of the students who measured the perimeter reported results in this range. This is about the same success rate as for those who measured the length.

Table 6-12
Length of Rectangle

Response	Examples	Percent
Correct	71, 72mm, 7cm2mm, 71m.m.	30
Correct, in cm	7.2 cm, 7.1cm.	3
Close	70m.m, 73mm, 70.1mm	5
Found width	31mm, 30mm, 3.1cm	4
Found perimeter	204, 21m, 20.6, 200mm, 20.4 cm	45
Other	42, 8mm, 2201mm, 106mm., 3by7, 430mm, 771mm, 14.20m	13

Another item in which measurement was embedded asked students to determine the radius, to the nearest millimetre, of a given circle with centre point marked. The radius was between 19mm and 20mm, and both values were accepted as correct. Results are shown in Table 6-13.

Table 6-13
Length of Radius

Response	Examples	Percent
Correct	19, 19mi, 1cm9mm, 20mm, 2cm0mm	61
Correct, in cm	1.9, 2cm., 1.9cm	6
Incorrect units	2 mm, 1.9mm, 2	2
Close	18mm, 20.5mm, 21mm	1
Found diameter	39, 3.8, 4cm, 38mi, 3.9mm, 39m.m.	11
Other	33, 10.6, 69mm, 120mm, 12.56	13
No response		6

More students omitted this item, 6%, than any other item dealing with length; probably because they were not sure about the meaning of the word radius. Twelve percent of the students measured the diameter, and a few attempted to calculate the circumference, 120mm, or the area, 12.6 square cm. About two-thirds of the students gave the correct length and units although some expressed the length in centimetres. This proportion is roughly the same as for the two other items which asked for lengths to the nearest millimetre. Such performance is not particularly strong, and the overall results are consistent with the frequency of student activities using linear measurement in class. It seems evident that students need to be engaged in much more measurement activity in class.

On one item students were asked to draw a segment 67 mm long, given one endpoint. This item was complementary to the one which asked students to measure a given segment. Results were: correct, 74%; close, 68mm, 14%; close, 66mm, 5%; and other, 7%. When the markers measured the segments drawn by the students, they found it difficult to determine what precise length the students had intended. The size of endpoints proved to be a problem, and a range from 66 to 68 mm was considered acceptable. On this basis, 93% of the students successfully completed the task. Thirty-two percent of the students felt compelled to label the other endpoint, and 6% indicated the other endpoint but neglected to draw the segment itself.

On Item 16 students were presented with a diagram of a rectangle and asked to determine its area, to the nearest square centimetre. The length was between 6.2 and 6.3 cm and width between 3.2 and 3.3 cm. Using the two shorter dimensions leads to an area of 20 sq. cm; using the longer dimensions, an area of 21 sq. cm. The choice of dimensions for this rectangle was particularly unfortunate because the perimeter (19 cm) is close to the numerical value for the area. An examination of students' work on the booklets showed that at least 6% of the students calculated the perimeter and 20% of the students showed centimetres as the unit of measure. It may be that some of these measured incorrectly, found the perimeter, and fortuitously came to the correct numerical value for the area. Thus the results shown in Table 6-14 should be interpreted with caution.

About one-quarter of the students were successful on this item. A large number gave an approximate answer of 18, likely arrived at by first approximating the length and width to the nearest centimetre (6 by 3) and then multiplying. Unfortunately, they would have also found the same value by calculating the perimeter using these measures. About 17% indicated a length of 6 and width of 3 on their diagrams, 31%

showed values correct to the nearest millimetre, and 47% showed no values at all. Three percent of the students actually marked off the rectangle and counted squares. Three percent also showed a correct formula, and 30% showed correct work with no formula. Three percent used an incorrect formula such as 2lw or lwlw.

Table 6-14
Area of a Rectangle

Response	Values	Percent
Correct	20	20
Correct	21	4
Approximate	18	36
Exact	19.84, 20.16, 20.46, 20.79	8
Other		21
No response		3

Use of Protractor

The second series of questions dealt with angular measure, and all items required a measurement to the nearest degree. On the first item students measured an acute angle which opened to the right. The actual measure was between 48 and 49 degrees. Results are indicated in Table 6-15.

Table 6-15
Measure of Acute Angle Opening to the Right

Response	Values	Percent
Correct	49	41
Correct	48	9
Close	47, 50	22
Supplementary	130, 131, 132	7
Reversed scale	51, 52	3
Complementary	40, 41, 140	4
Other		17
No response		1

Only half the students gave a correct response. About one quarter were close but were careless in positioning the protractor, while 10% positioned the protractor correctly but misread the scale. Others placed the protractor with the 90 degree ray along one arm of the angle (e.g., 40, 140), combined the scales (e.g., 150), measured the distance from B to A (e.g., 4), or gave answers which were impossible to interpret.

The next item was designed to see if students were able to use the second scale, which was marked clockwise on the protractor, and they were asked to find the measure of an acute angle opening to the left. The actual measure of the angle was between 30 and 31 degrees. Results are shown in Table 6-16.

Table 6-16
Measure of Acute Angle Opening to the Left

Response	Values	Percent
Correct	30	38
Correct	31	32
Close	29, 32	5
Supplementary	149, 150	9
Supplementary close	148, 151	1
Other		13
No response		2

Seventy percent answered this item correctly. This result was surprising as the angle was placed in an unconventional orientation. The reason for the better performance on this item than on the previous one may lie in the location of the scales on the protractor. The outer scale, easier to apply, is clockwise, and the inner, counter-clockwise. About 10% of the students declared a measure of around 150 degrees, thereby showing a lack of understanding of degree measure or a failure to check the reasonableness of results.

In the third item students were asked to measure an acute angle within a triangle. The angle had one horizontal arm, opened to the right, and measured between 77 and 78 degrees. Because the protractor did not show lines radiating from the centre, it was necessary for students to extend one side of the triangle in order to obtain an accurate answer. This extension was shown in only 19% of the cases. Results are shown in Table 6-17.

The failure to extend the side of the triangle seems to have resulted in fewer correct responses and a higher proportion of approximate responses than on the first item.

Some students measured the wrong angle, and a few others summed the lengths of two or three sides of the triangle.

Table 6-17
Measure of Acute Angle in a Triangle

Response	Values	Percent
Correct	78	37
Correct	79	6
Close	77, 80	27
Supplementary	101, 102	2
Supplementary, close	100, 103	4
Reversed scale	81, 82	3
Measured another angle		2
Other		16
No response		3

The final item of those dealing with angular measurement required students to determine the measure of an obtuse angle in a pentagon. The angle opened up, neither side was horizontal, and one had to be extended for accurate measurement. The angle measured between 142 and 143 degrees. Results are shown in Table 6-18.

Table 6-18
Measure of Obtuse Angle in a Pentagon

Response	Values	Percent
Correct	142	26
Correct	143	16
Close	141, 144	5
Approximate	140, 145	22
Supplementary	37, 38	8
Supplementary, close	36, 39	1
Supplementary, approximate	35, 40	5
Measured from horizontal	20, 160, 163	4
Other		17
No response		6

The proportion of correct responses on this item was consistent with that on the previous item. Only 22% of the papers indicated that a side had been extended. For this item, the extension is just about mandatory for a correct response. The large proportion of approximate answers shows that students tended not to add any construction lines to the figure. About 4% appeared to have placed their protractor horizontally on the figure and read some scale combination to arrive at a result.

On two items students were asked to draw angles, one an angle of 37 degrees, and the other a right angle. Results are shown in Table 6-19.

Table 6-19
Drawing a 37 degree Angle and a Right Angle

Response	Percent	
	37 degrees	Right angle
Correct	57	67
Close (within one degree)	21	16
Approximate (within two degrees)	4	2
Supplementary	1	-
Other	12	11
No response	5	4

Students recognized that a right angle measured 90 degrees and were more successful in constructing this angle than one of 37 degrees. The presence of a 90 degree line on the protractor may have helped. About 80% of students oriented the angle with one arm horizontal and opening right. About 10% opened left, and this imbalance demonstrates a particular mind set which is engendered by the use of a particular orientation in textbooks. About 60% of the students showed only segments rather than rays, while 16% showed rays. This may indicate a movement away from the more formal requirements of the new geometry of the 1960s. Between 15 and 28 percent of the students showed arcs on their diagrams and this seems to indicate that they felt it necessary to trace the circular portion of the protractor to locate the desired position of the second arm.

Two items were designed to assess students' ability to combine the use of the two instruments. In one, students had to construct a square in which each side was 4 cm long. Thirty-seven percent of the students drew a square in which each angle was exactly 90 degrees and each side was exactly 4 cm. When a degree tolerance was allowed on the right angles, 88% of the responses showed figures with nearly right angles. When a millimetre of tolerance was permitted on the length of the sides, 92% showed nearly equal sides. Altogether, 82%

consisted of either squares, or near squares. One percent of the students drew a square with sides of 3 centimetres. In general, this question was well answered, although it is clear that a little more care in the construction would have improved performance.

On the final item students were told: "Fred had a problem. His teacher asked him to use a ruler and protractor to construct a triangle in which each side was 5 cm long. Write down some things you could tell Fred to help him out." Following this, they were instructed: "If you can do Fred's problem, show it below."

The intent of this question was to determine whether students could relate the equilateral nature of the triangle to the equiangular requirement. Following this, the question was whether they knew the sum of the measures of the angles to be 180 degrees and of each angle, therefore, 60 degrees. The procedures suggested by students are shown in Table 6-20.

Table 6-20
Methods for Constructing an Equilateral Triangle

Method	Percent
Three angles of 60 degrees	21
Part correct, e.g., based on 2 equal angles	8
Perpendicular bisector	23
Part correct, based on use of perp. bis.	5
Trial and error, no check on angles	11
Trial and error, check angles with protractor	4
Incorrect reasoning on properties	4
Misinterpretation, e.g., draw square	5
Other	11
No response	9

An attempt was made to determine whether their actual constructions agreed with what they advised Fred to do. Complete agreement was found in 63% of the cases, partial agreement in another 10%, and the relationship was not clear in 11%. In only 5% of the cases was there no apparent connection. Thirty-one percent of students produced the required triangle. If a tolerance of a millimetre is permitted on each side, 65% of the students were successful in constructing an exactly or nearly equilateral triangle. Nine percent did not attempt the question.

Summary

Most Grade 7 students own rulers and protractors, but fewer than half reported using them to measure distances or angles during the school year. About 90% of the students were able to determine the length of a given line segment to the nearest centimetre but only two-thirds could do so to the nearest millimetre. Considerable confusion exists as to the proper symbols for metric units of linear measurement. Almost half of the students could determine the measure of an angle to the nearest degree, and about 60% could draw an angle of a given measure.

These results indicate that students need more practice in the use of the ruler and protractor, both in measuring and constructing geometric figures. Teachers should not assume that students at this level are proficient in the use of these instruments even though they may have been exposed to them for a number of years in the elementary grades.

Results on the items dealing with circles and rectangles indicate that students were not sure about the meaning of geometric terms such as radius, area, perimeter, and length of a rectangle. Teachers should review these concepts regularly with their students and ensure that new terms are clearly understood.

Form Q-1: Grade 10

The Grade 10 Q1-Form was designed to assess students' understanding of basic algebraic concepts and relationships, and the instrument was a virtual duplicate of the one used in a British study of algebraic thinking of 13-to-15-year old children (Hart, 1981). Students in Grade 10 in British Columbia generally are 15 years old so the population match is reasonably good. Moreover, the content of the British test matched well the algebraic component of the British Columbia Grade 9 and 10 curriculum.

For ease of reporting in this section the items have been grouped under six main headings: algebraic manipulation, equations, relative magnitudes, explanation, application, and translation.

Algebraic Manipulation

Three multi-part items were used to assess students' ability to simplify and construct algebraic expressions. On Item 15, students were asked to simplify a number of expressions, where possible. The expressions were: $2a + 5$, $2a + 5b$, $(a + b) + a$, $2a + 5b + a$, $(a + b) + (a - b)$, $3a - (b + a)$, $a + 4 + a - 4$, $3a - b + a$, and $(a - b) + b$.

For items which contained no parentheses or parentheses with only signs of addition, the success rate ranged from 71 to 86 percent. A typical error was to add the numerical values and collect the literals into one expression, for example, $2a + 5b + a = 8ab$. When parentheses were introduced, a common error was to assume that some form of multiplication was required, for example, $(a + b) + a = a^2 + b$, and this was not the case in any expression. When parentheses and signs for subtraction were combined, the success rate dropped to a range of 45 to 60 percent.

The two other items in this section required the students to state the sum and product of 4 and each of $n + 5$ and $3n$. Results are shown in Table 6-21.

Table 6-21
Creating Expressions

Task	Response	Percent
Add 4 to:		
$n + 5$	$n + 9$	71
	$n + 5 + 4$	15
	9	8
$3n$	$3n + 4$	81
	$7n$	6
	12	4
Multiply by 4:		
$n + 5$	$4n + 20$	45
	$4(n + 5)$	17
	$n + 5 \times 4$	13
	$n + 20$	8
	$20n$	4
	20	3
	9	2
$3n$	$12n$	64
	$4(3n)$	11
	$3n \times 4$	10
	12	8
	$7n$	2

A substantial minority of students, from 15 to 20 percent, gave an incomplete result which could have been simplified further, for example, $4(3n)$. Students had difficulty in applying the distributive principle on the multiplication item, as was the case on the previous simplification question. A small group of students substituted the value of 4 for the variable in each expression.

Equations

One of the three items under this heading was designed to examine how students balance an equation, using both numerical and algebraic operators. Results are shown in Table 6-22.

Table 6-22
Balancing an Equation

Task	Response	Percent
If $a + b = 43$, then $a + b + 2 =$	45	96
	41	1
If $n - 246 = 762$, then $n - 247 =$	761	84
	763	3
	269	3
If $e + f = 8$, then $e + f + g =$	$8 + g$	66
	12	8
	9	4
	$8g$	3
	16	3
	15	2

On the first task it was necessary only to recognize that 2 must be added to the right side, and virtually all students were correct. In the second part students had to recognize that subtracting a larger number decreases the difference. The response 269 was obtained by subtracting 246 and 247 from 762. In the final task, the numerical values were arrived at by assuming some relationship of equality among the three literals. The value of 15 is the sum of 8 ($e + f$) and 7 (the ordinal position of g in the alphabet).

Another item was used to assess students' understanding of the equality relationship in a strictly algebraic sense. Students were asked whether $A + B + C = C + A + B$ would always, never, or sometimes (and under what conditions) be true. Ninety-one percent said "always", and 5% said "sometimes". Students were asked the same question for $L + M + N = L + P + N$. A surprising 46% said "never", 41% said "sometimes, when $M = P$", and 7% said "sometimes". This seems to show that students think the use of different letters prohibits two variables from having the same value. They appear to focus on the form of the variable rather than on the notion of a letter representing any numerical value.

Relative Magnitudes

Two items were designed to determine whether students could identify the largest and smallest of a set of algebraic expressions. On the first item they were asked which was the smallest and which the largest of: $n + 1$, $n + 4$, $n - 3$, n, $n - 7$. For the smallest, 85% correctly identified $n - 7$, and 9% said n, perhaps thinking that smallness was guaranteed by the lack of an attached numerical value. Ninety-two percent correctly identified $n + 4$ as the largest, while 4% said $n - 7$, likely looking at the absolute value of the number being subtracted.

The second item required a much more complex analysis: "Which is larger: $2n$ or $n + 2$? Explain your answer.". Sixty-one percent chose $2n$, while 9% said $n + 2$ was larger or the same. A fully satisfactory answer was deemed to be one in which students indicated that $2n$ was larger and also noted the exception of at least two values of 2, 1, or 0. On this basis, 18% were successful. A further 6% listed only one exception, and 4% said only that $2n$ was usually larger. Overall, about 29% of the students demonstrated some understanding of the complexity of the relationship.

One argument for suggesting that $2 + n$ was larger went as follows: "$2 + n$ is bigger because for eg: I had 2 dollars and n is an apple that means I had $2 and an apple and $2n$ = I had 2 apple only." Such a response demonstrates the difficulty which may arise when students have to rely on concrete interpretations of abstract algebraic concepts.

Algebraic Explanation

The items in this subset were phrased in a way which invited students to express their answers in other than simple numerical fashion. Each began with the phrase: "What can you say about .... if ....?". Responses which were given by 5% or more of the students are indicated in Table 6-23.

Students did very well on items such as Item 9a which required a simple numerical solution, and on items where a simple substitution yielded the correct answer, for example, Items 13a and 13b. In these instances the letter in question has a specific value. Another case of this is Item 9b, but here the connection is more complex. A large proportion of the students did not even attempt this item and only one-half were successful. Students who gave incorrect responses showed a tendency toward a mechanical solution of the problem without assessing the appropriateness of the result. The success rate for Item 16 was felt to be quite good, indicating either a good understanding of the conditions of the problem or a correct choice for substitution.

On Items 21a and 21b which dealt with increases in variable values, about two-thirds of the students were successful. Incorrect approaches focussed on algebraic manipulations in attempting to demonstrate the new relationship using the same variables. Such approaches are characteristic of students who do not understand the concept of a letter as a generalized number, that is, they assume the value of the letter remained constant. On the one item dealing with inequality, Item 18, about half the students were successful, assuming that the replacement set is the set of natural numbers.

Table 6-23
Algebraic Explanations

Item	What can you say about ...	Response	Percent
9a.	a if $a + 5 = 8$?	$a = 3$	96
9b.	b if $b + 2$ is equal to $2b$?	$b = 2$	55
		$b + 2 = 2b$	5
13a.	u if $u = v + 3$ and $v = 1$?	$u = 4$	94
13b.	m if $m = 3n + 1$ and $n = 4$?	$m = 13$	92
16.	r if $r = s + t$ and $r + s + t = 30$?	$r = 15$	52
		$r = 10$	8
		$r = 30 - s - t$	5
18.	c if $c + d = 10$ and c is less than d?	systematic list	24
		$c < 5$	19
		one value only	16
		$c < d$	10
		$c \leq 4$	6
		$c = 10 - d$	5
21a.	if $a = b + 3$ and b is increased by 2? *	a increases by 2	60
		$a = 5$	8
		$a = b + 5$	7
		a increases	5
21b.	f if $f = 3g + 1$ and g is increased by 2? *	f increases by some value	28
		f increases by 6	25
		f increases	9
		$f = 7$	7

* not exactly as worded in original

Applications to Measurement

Two items were used to evaluate students' ability to express, in algebraic terms, the area and perimeter of geometric figures. The area item presented four rectangles, of dimensions: 4 by 3 (squares shown), 10 by 6, n by m, and 5 by 2 + e. In the first three rectangles, correct responses were a consistent 89 percent. Popular incorrect procedures were: twice the length times the width (5%, 6%, 3%), length squared plus width squared (2%, 1%, 2%), and length plus width (2%, 1%, 1%). On the fourth rectangle, where the correct answer was 5(e + 2) or equivalent, the success rate was 43%. Incorrect responses included 10e (23%), 5e2 (4%), 5e + 2 (3%), e + 10 (2%), and 2e x 5 (2%). The inference to be drawn here is that the area concept is clear for most students but their ability to manage other than the simplest algebraic formulation is in doubt.

On the perimeter item, students were presented with four geometric figures: a triangle with sides e,e, and e; a pentagon with sides h,h,h,h, and t; a pentagon with sides u,u,5,5, and 6; and an incomplete polygon having n sides, of which 11 were shown, each of length 2. Results are presented in Table 6-24.

Table 6-24
Perimeters of Polygons

Figure	Sides	Response	Percent
Triangle	e,e,e	3e	97
Pentagon	h,h,h,h,t	$4h + t$	77
		$4h + 1t$	4
		$4ht$	12
		$5h$	2
Pentagon	$u,u,5,5,6$	$2u + 16$	64
		weak, e.g., u + u + 16	15
		$2u + 31$	3
		150 x $2u$	2
		$2u16$	2
		$16n$	2
Incomplete	2,2,2,2,...	$2n$	49
		$n2$	6
		n	4
		$11n$	3
		22	3
		$22n$	2
		no response	16

For the two pentagons, about 80% of the students gave acceptable answers, and this is a high success rate. The final figure was more complex on two counts: it was not a closed figure, and the variable referred to the number of sides rather than to the length of each side. A substantial number of students, 16%, did not attempt the item. Even so, 55% of the students were correct. Overall, student performance on the two items in this category was quite satisfactory.

Algebraic Translation

Table 6-25
Translations into Algebraic Expressions

Item	Response	Percent
14. If David has D records and Wendy has T records, what could you write for the number of records they have altogether?	$D + T$	85
	DT	9
	$D \times T$	2
17. In a shape like this [pentagon] you can work out the number of diagonals by taking away 3 from the number of sides. So, a shape with k sides has ___ diagonals.	$k - 3$	75
	k	6
	l or other letter	5
	no response	6
19. Tom's basic wage is $200 per week. He is also paid another $10 for each hour of overtime that he works. If h stands for the number of hours of overtime that he works, and if W stands for his *total* weekly wage (in dollars), write down an equation connecting W and h.	$W = 200 + 10h$	27
	$W + h$	17
	$W = 200 + h$	11
	$W + 10h =$ wages	8
	$W + 10h$	4
	$200W + 10h$	4
	$200 = W + h$	2
	$W = W + h$	2
	no response	6
22. Muffins cost m cents each and buns cost b cents each. If I buy 4 muffins and 3 buns, what does $4m + 3b$ stand for?	total cost,	47
	"cost of muffins & buns"	21
	4 muffins, 3 buns	9
	implied total	7
	number of muffins & buns	5
24. Blue pencils cost 5 cents each and red pencils cost 6 cents each. I buy some blue and some red pencils and altogether it costs me 90 cents. If b is the number of blue pencils bought, and if r is the number of red pencils bought, what can you write down about b and r?	$5b + 6r = 90$	55
	$b + r = 90$	20
	$b = 12, r = 5$	3
	$b = 6, r = 10$	2
	2 or more correct pairs	2
	incorrect pair	3
	no response	5

Items 14, 17, 19, 22, and 24 consisted of mathematics word problems for which students were asked to write algebraic statements. The items, together with the most frequently occurring responses, are shown in Table 6-25.

Most students were able to carry out a simple translation, as in Item 14. Performance was somewhat weaker on Item 17 in which an inference had to be drawn from the example. Item 19 required students to combine two variables and a constant in an equation, and this task proved to be very difficult, with only 27% success rate. In a second part to this item students were asked what Tom's total wage would be if he worked 4 hours of overtime, and 85% of the students gave a correct response. This indicates that students did not find it necessary to state an equation formally in order to solve the problem. If algebraic translation is to be emphasized, teachers should require students to write the appropriate equation. On the other hand, if the goal is for students to arrive at a correct answer to a problem, then students should be encouraged to use whatever method they feel is suitable.

Item 22 required students to explain the meaning of a given algebraic expression. About half the students were explicit in stating the result. Another quarter gave a weaker, yet correct, answer. Some students equated the symbols with the objects rather than with the cost of the objects, that is, $4m + 3b$ was thought to be "4 muffins and 3 buns".

Item 24 was an extension of Item 22, and students were required to construct an equation with two variables. In the British study, this item was classified as one which required the highest level of algebraic understanding, and the 55% success rate of British Columbia students was very good. When partial solutions were included, the success rate exceeded 60%. Only 8% of the 15-year-olds in the British study succeeded on this item.

Summary

Students at the Grade 10 level in the Q-1 sample were able to deal well with simple algebraic concepts and manipulations. However, it must be kept in mind that the Grade 10 sample has been demonstrated to be of a higher ability level than the population of students. Results reported for this group may be interpreted as upper limits for the general range of student abilities.

The results on less mechanical and more conceptual items indicate that students require extensive work on the fundamental ideas of algebra. Such questions as whether $L + M + N$ equals $L + P + N$, and which of $2n$ or $n + 1$ is larger, focus on the concept of a letter as a variable, rather than as a specific value to be uncovered. Students can be helped in their understanding of algebra through the use of concrete situations such as the pencil problem (#24), in which each variable can take on more than one value, but which are restricted to a range because of the conditions of the problem. Such problems may provide insights into algebraic relationships which are not evident through mechanical exercises set for the sole purpose of graphing linear relations.

Q-2 Form Results

At each grade level, the Q-2 Forms were designed to assess children's ability to compute, to solve traditional word problems, and to solve word problems which require the use of more than a simple equation or computation. The traditional word problems were structured so as to require computations very similar to those on the computation items. The subtests were labelled Computation, Word Problems, and Problem Solving, and the number of items contained in each subtest is reported in Table 6-26.

Table 6-26
Composition of Subtests

Subtest	Number of Items Grade 4	Grade 7	Grade 10
Computation	6	7	7
Word Problems	7	7	7
Problem Solving	5	6	6
Total	18	20	20

The Computation Subtest

The four basic operations of addition, subtraction, multiplication and division were tested at each grade level. At Grade 7, coverage was extended to include order of operations and at Grade 10 a further extension included percent and solving linear equations.

Grade 4

At the Grade 4 level there were two addition items: one required students to find the sum of three 2-digit numbers; and the other, the sum of two 3-digit numbers. Two items involved subtraction: one with whole numbers, and the other with money units containing decimals. The remaining two items involved multiplication and division of money units with decimals.

Students performed well on all but one item in this subtest. On five items p-values ranged from 66 to 97. The most difficult item required students to divide $27.00 by 6, and only 38% answered the item correctly. The most common error on this item, made by 25% of the students, was to place the decimal incorrectly. Students also found use of the dollar sign confusing. Several alternate responses were: 4R3, 4R$3, $4R$3 and 4.3.

Students did very well on Item 8, "Add: 263 + 432", which had a p-value of 93. An interesting error made by a number of students was to reverse the order of numbers for addition, resulting in an answer of 596.

Grade 7

The subtest at the Grade 7 level included one item each on addition, subtraction, multiplication, and division of decimals; one question on the product of 3 factors; and two on order of operations. P-values for these items ranged from 68 to 97 with a mean of 81. Item 10, shown in Figure 6-5, proved the most difficult but was still done well with a correct response rate of 68%. Among those who answered this question correctly there were many who added the fractions and then converted the sum to a decimal before multiplying.

Evaluate:

$$\left(\frac{2}{5} + \frac{1}{5}\right) \times 45$$

Figure 6-5. Grade 7 Q-2, Item 10.

Grade 10

Items on the Grade 10 subtest included the four basic operations with mixed numbers. In addition to an order-of-operation item which was also contained on the Grade 7 form, there was an item on percent and another requiring the solution of a linear equation. The p-values on this subtest ranged from 68 to 93 and the mean was 79.

On Item 5, students were asked to evaluate 2 x 7 + 2 x 9, and 87% were correct, compared to 69% at the Grade 7 level. The most common error, made by 10% of respondents, involved an incorrect order of operations where students added 7 and 2 before multiplying.

Item 6, "35 is what percent of 175?", was answered correctly by 68% of students. The most common errors were to take 35% of 175, made by 8% of students, and to divide 175 by 35, made by 11%.

Summary

Results from the Q-2 Forms indicate that students' facility with basic computation is, for the most part, very good. Areas in which there is room for improvement, however, are place value with decimals at Grade 4 and order of operations at Grades 7 and 10. This suggests that teachers should stress the relationship between common and decimal fractions in the early grades, and order of operations using the distributive principle at intermediate and junior secondary grade levels.

The Word Problem Subtest

The Word Problem subtest at each grade level consisted of routine story problems involving basic operations similar to those in the Computation subtest. The purpose of this subtest was to compare student performance on simple basic operations with those same operations carried out in the context of routine applications. For this reason pairs of items requiring similar operations are linked for reporting purposes.

This subtest contained seven items at each grade level. In Table 6-27 item pairs are identified where the first element in each ordered pair is from the Computation subtest and the second is its counterpart from the Word Problem subtest.

Table 6-27
Computation and Word Problem Item Pairs

Grade 4	Grade 7	Grade 10
4,10	4,12	4,11
5,13	5,15	5,12
6,12	6,16	6,13
7,11	7,11	7,14
8,15	8,14	8,15
9,16	9,13	9,16
	10,17	10,17

An example of a set of paired items, Items 4 and 10, from the Grade 4 Q-2 Form is shown in Figure 6-6.

4. Add: $$\begin{array}{r} 98 \\ 35 \\ +\underline{31} \end{array}$$

10. Betty, Mary and Sue want to buy their mother a present for Mother's Day. Betty has 58 cents; Mary has 75 cents; Sue has 89 cents. How much money do they have altogether?

Figure 6-6. Grade 4 Q-2, paired Items 4 and 10.

Grade 4

Correct response rates on items from this subtest ranged from 66% to 93% with an average percent correct of 85. In reviewing student responses to these items the markers recorded evidence of which problem-solving strategy was used. The strategies looked for included: write an equation, draw a diagram, guess and test, make a list, look for a pattern, and make a simpler problem. The most frequently used strategy was "write an equation". Use of this strategy ranged from a low of 74% on Item 16 to a high of 91% on Item 10. Rather than use alternate strategies on Item 16 the majority of the balance, 22% of the total, showed no strategy at all.

Performance on Item Pairs. Comparisons between performances within each pair of items provide some interesting results which are reported in Table 6-28.

Table 6-28
Performance Comparisons on Item Pairs for Grade 4
(Percent Correct)

Item Pair	Neither Correct	First Item Only Correct	Second Item Only Correct	Both Items Correct
4,10	2	12	4	82
5,13	-	11	2	86
6,12	13	10	10	67
7,11	9	11	25	55
8,15	1	6	6	87
9,16	39	8	22	22

The highest correct response rate, 87%, was on item pair 8,15. These questions involved the addition of two 3-digit numbers. Item pair 9,16 which involved the division of money units proved most difficult, with only 22% answering both successfully. Approximately 8% of students answered the first item in this pair correctly but were unable to solve the related word problem, whereas 22% of the students answered the word problem correctly but made an error on the computation item. This contrasts with the performance on item pair 5,13 on which 11% correctly answered the computation item only and only 2% could answer the word problem but not its computational counterpart.

Grade 7

Performance on items in this subtest ranged from 58 to 93 percent correct, with a mean of 81%. Item 14, shown in Figure 6-7, proved the most difficult with 58% of the students answering correctly. The most frequent error on this item was incorrect placement of the decimal, made by 21% of the students. Two errors of interest made by several students involved the cubing of 15.5 and 2480, and multiplication of the numbers by 3. These students obviously confused cubic units as a measure of volume with powers and products of numbers.

14. A dump truck can hold 15.5 m^3 of gravel at one time. How many trips would be required to haul away 2480 m^3 of gravel?

Figure 6-7. Grade 7 Q-2, Item 14.

The most popular strategy on the set of Word Problems was to write an equation. Use of this approach ranged from 62% of the students on Item 16 to 97% of the students on Item 12. The only other strategy used frequently was to draw a diagram, which was used by 15% of the students on Item 16, and 13% on Item 13 (see Figure 6-8). Both items are based on geometrical knowledge and lend themselves to pictorial representation.

13. What is the area of a rectangular piece of cloth that measures 8.5 centimetres by 15 centimetres?

Figure 6-8. Grade 7 Q-2, Item 13.

Performance on Item Pairs. Performance on items contained in each combination and on the pair as a whole is shown in Table 6-29. Students found item pair 4,12 to be the easiest with 88% answering both items correctly and only 1% missing both. The calculation for these items involved the sum of three decimal fractions.

Table 6-29
Performance Comparisons on Item Pairs for Grade 7
(Percent Correct)

Item Pair	Neither Correct	First Item Only Correct	Second Item Only Correct	Both Items Correct
4,12	1	7	4	88
5,15	1	28	2	69
6,16	15	25	16	44
7,11	2	7	8	83
8,14	25	21	4	51
9,13	12	22	10	56
10,17	19	18	13	51

The most difficult item pair was 6,16, shown in Figure 6-9, and both items involved order of operations. Only 44% answered both correctly and 15% were unable to answer either one. The most frequent error in Item 6, made by 26% of the students, involved performing the operation of addition before multiplication. On Item 16 the most frequent errors involved order of operation and use of the formula for area rather than perimeter.

6. Evaluate: 2 x 7 + 2 x 9

16. Mr. Jones put a fence around his rectangular garden. The garden is 10 m long and 6 m wide. How many metres of fencing did he use?

Figure 6-9. Grade 7 Q-2, Items 6 and 16.

Grade 10

Grade 10 students averaged 75% correct on this subtest, and p-values ranged from 56 to 87. One of the difficult items was Item 11 which only 62% of the students answered correctly, compared to 58% at Grade 7 who responded to the same item (see Figure 6-7). The most common error, committed by 24% of the students, involved incorrect placement of the decimal. Several students, as was the case in Grade 7, misunderstood the cubic unit and raised the numbers to the power 3.

Item 15, shown in Figure 6-10, was answered correctly by 56% of students. The most common error, made by 17%, involved the incorrect placement of the decimal in the answer. Other frequent errors involved the use of incorrect formulas, such as surface area and total length of edges.

15. Find the volume of this box

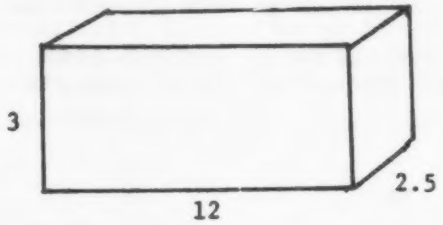


Figure 6-10. Grade 10 Q-2, Item 15.

The strategy most often used on this set of items was to write an equation. Use of this approach ranged from 92% of students on Item 16 to 45% on Item 12. On average, this approach was used by 78% of the students on all items in this subtest. The only alternate strategy used to a noticeable extent was to draw a diagram, used by 41% of the students on Item 12 and 18% on Item 14.

Performance on Item Pairs. Student responses to items in each pair are recorded in Table 6-30.

Table 6-30
Performance Comparisons on Item Pairs for Grade 10
(Percent Correct)

Item Pair	Neither Correct	First Item Only Correct	Second Item Only Correct	Both Items Correct
4,11	15	23	5	57
5,12	6	17	7	70
6,13	15	10	18	57
7,14	6	5	18	71
8,15	16	34	9	41
9,16	13	14	12	62
10,17	5	35	2	57

Performance on item pairs 5,12 and 7,14 was highest with 70 and 71 percent of the students respectively answering both items in each pair correctly. Students who were able to solve just one item in each pair did not show a consistent pattern of correct and incorrect responses on the computation and word problem items. For example, 17% of students answered Item 5 correctly but not the corresponding word problem, whereas 7% gave the correct answer for Item 12 and not for its computational counterpart, Item 5. This contrasts with pair 7,14 (see Figure 6-11) where 5% answered only Item 7 correctly and 18% gave a correct response to only Item 14. The result on the latter pair may indicate only that students can carry out a computation using a denominator of 2 more easily than 4. It may also be that Item 14 can be solved readily by using a diagram, and 18% of the students used this approach.

7. Divide:

$$26 \div 3\frac{1}{4}$$

14. A carpenter cuts a board 10 metres long into lengths of 2 1/2 metres. How many lengths will he get?

Figure 6-11. Grade 10 Q-2, Items 7 and 14.

Item pair 8,15 was the most difficult for students. Only 41% answered both items correctly and 16% were unable to answer either. These items involved the product of three factors, one of which included a decimal fraction.

Summary

Results from this subtest indicate the presence of computational errors similar to those in the Computation subtest. For the most part, students who were able to perform routine calculations were also able to deal with them successfully in a story problem context. This observation is borne out by results from the item pairs. Of those students who were able to answer the first item in each ordered pair, the percentage who proceeded to answer the corresponding word problem correctly ranged from 80 to 93 at Grade 4, 64 to 92 at Grade 7, and 54 to 94 at Grade 10.

The Problem-Solving Subtest

Each item contained in the Problem-Solving subtest required two or more steps for a solution, and were of a non-routine nature. The purposes of this subtest were to investigate the problem-solving strategies students utilized, to examine patterns of errors which emerged, and to compare performance to that on the Word Problems subtest.

Grade 4

The Problem-Solving subtest at Grade 4 consisted of Items 17 to 21. Performance on these items ranged from 26% to 82%

correct, with an average of 52% correct. Students found Item 18, shown in Figure 6-12, to be the most difficult, and only 26% gave correct answers. A review of incorrect responses on this item showed that 49% of the students gave an incorrect and unreasonable answer. The most frequent errors included finding the sum of 4 and 24, summing 24 and 28, and finding any two numbers which summed to 24. Fifty percent of the students did not show work from which a strategy could be identified, however, 48% wrote an equation. The use of a table or diagram as a problem-solving strategy would have assisted students greatly in this item.

18. Jerry has a total of 24 golf balls and tennis balls. If he has 4 more tennis balls than golf balls, how many of each does Jerry have?

Figure 6-12. Grade 4 Q-2, Item 18.

Fifty-one percent of the students answered Item 19 correctly (see Figure 6-13). Most students, 52%, showed no work from which a strategy could be identified while 27% wrote an equation. Many students drew a line above the sixth paper clip and counted the corresponding number of buttons. Very few students used a ratio for this question, and it may be that more emphasis should be placed on ratio and proportion in the classroom.

19. The stickman below is Mr. Big. He is 9 paper clips tall or 6 buttons tall. There is another stickperson, Mr. Short, who is 6 paper clips tall. How many *buttons* tall would he be?

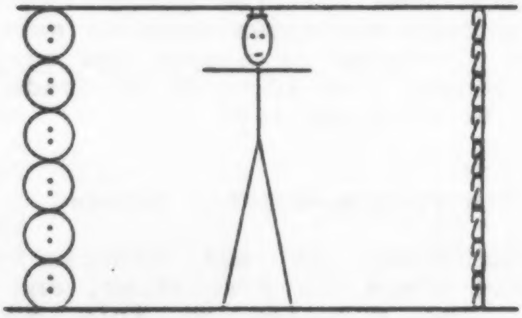


Figure 6-13. Grade 4 Q-2, Item 19

Grade 7

Items 18 to 23 constituted the Problem-Solving subtest at the Grade 7 level. The p-values for these items ranged from 46% to 78% and the average was 68%. The most difficult was Item 20, shown in Figure 6-14, to which only 46% of the students responded correctly. Ten percent gave an incorrect but reasonable answer whereas 51% gave an incorrect and unreasonable answer. The most popular strategy used on this item was to draw a diagram. Forty percent of the students used this approach compared to 30% who wrote an equation as their first step.

20. There are 6 fence posts on one side of a garden. The posts are 2 m apart. What is the distance from the first post to the last post?

Figure 6-14. Grade 7 Q-2, Item 20.

The most popular strategy used on items in this subtest was to draw a diagram. It was the first choice of students on Items 18, 20, 21, and 23. Guess and test was most often used on Item 19, by 19% of students, while students most often made a list on Item 22, 54%. The use of different strategies was more apparent at Grade 7 than at Grade 4.

Grade 10

The Problem-Solving subtest at the Grade 10 level consisted of Items 18 to 23. Student performance on these items ranged from a low of 43% to a high of 80% correct, and the mean for this subtest was 68%. At 43% correct, Item 18 was the most difficult, and is shown in Figure 6-15. Many students translated $6m^2$ to 36m, and this shows a lack of understanding of the difference between the use of an exponent to describe a unit and to raise a number to a power. This misinterpretation is consistent with the confusion over cubic units in Item 11 of the Word Problems subtest. Fifty-seven percent of the students used an equation as their strategy for this item, whereas 20% used a diagram.

18. A litre of asphalt paint will cover about 6 m^2 of surface. The paint is sold in cans of 5 litres only. How many cans are needed to paint a driveway 15 m long and 3 m wide?

Figure 6-15. Grade 10 Q-2, Item 18.

Alternate Test Forms

Seventy-three percent of students correctly answered Item 19, shown in Figure 6-16. The most popular strategy on this item, used by 62% of students, was to make a list. Many students looked for combinations but did not check to see if more than one combination could result in the same amount.

19. Some candies cost 10 cents each and others cost 25 cents each. Susan bought 3 candies. How many different amounts could Susan have spent?

Figure 6-16. Grade 10 Q-2, Item 19.

Summary

The mean of 68% on the Problem-Solving subtest was the lowest of the three subtests. This was also the case at Grade 4, 52%, and Grade 7, 68%. These results are not surprising, however, since items contained in the Problem-Solving subtests measure student achievement at higher cognitive behaviour levels than the others. With the exception of the Problem Solving subtest at Grade 7, writing an equation was the most popular problem-solving technique. It is recommended that teachers stress alternate problem-solving strategies in the classroom and encourage students to show their work.

Reporting Categories for Q-2 Forms

From information collected on the background questions, students were classified by sex at all grade levels and also by course preparation at Grade 10. These two categories were used to analyze differential self-perceptions of ability and demonstrated performance.

Differences by Sex

Students were asked to rate, on a 5-point scale ranging from "very well" to "poor", how well they felt they performed in mathematics. For reporting purposes responses were collapsed into three categories: above average, average, and below average. Results are shown in Table 6-31.

At each grade level, boys felt they did better in mathematics than girls, and this was most evident at Grade 10. There was also a trend toward lower positive ratings by both boys and girls as grade level increased. For example, above average ratings for girls were 56, 52, and 31 percent respectively. Similarly, boys' responses were 66, 60, and 51 percent. At the negative end of the scale the differences both between and within sexes was less extensive. From lows of 4% and 2% at the Grade 4 level by girls and boys respectively, negative self-perceptions of performance in mathematics increased by only 9 percentage points for girls and 8 percentage points for boys by Grade 10.

Table 6-31
Self-Perception of Mathematics Ability, by Sex
(Percent)

Rating	Grade 4		Grade 7		Grade 10	
	Boys	Girls	Boys	Girls	Boys	Girls
Above average	66	56	60	52	51	31
Average	32	40	34	42	39	56
Below average	2	4	6	6	10	13

Performance comparisons between boys and girls by subtests are reported in Table 6-32. Girls did slightly better than boys on the Computation subtest at each grade level. Results on the Word Problems subtest, however, show a higher performance by boys at the Grade 10 level. At Grades 4 and 10, boys outperformed girls in the Problem-Solving subtest. All differences in performance are small and are not as pronounced as differences in the self-perception of ability scale.

Table 6-32
Subtest Means, by Sex
(Percent)

Subtest	Grade 4		Grade 7		Grade 10	
	Boys	Girls	Boys	Girls	Boys	Girls
Computation	77	78	80	82	79	80
Word Problems	79	79	72	71	72	68
Problem Solving	47	43	68	68	70	66

Differences By Preparatory Course

Although only one mathematics course is officially prescribed at the Grade 10 level, most schools offer more than one. All of the various courses, however, can be classified into two categories: those which prepare students for Algebra 11, and those which do not. To identify these two groups, students at the Grade 10 level were asked whether or not the mathematics course they were currently taking, or had taken earlier in the year, prepared them to take Algebra 11. The purpose of collecting this information was to distinguish between performances of these groups on each subtest. In response to this question, 83% of the students claimed to be taking or had taken a course designed to prepare them for Algebra 11. The balance of the students are presumed to take Business or Trades Mathematics in Grade 11 or else will not take any further mathematics courses. A comparison of how these two groups of students perceived their individual levels of ability in mathematics is reported in Table 6-33.

Table 6-33
Self-Perception of Mathematics Ability, by Preparation in Mathematics
(Percent)

Rating	Preparation in Mathematics	
	Pre- Algebra 11	Alternate Course
Above average	45	14
Average	44	72
Below average	11	14

Forty-five percent of the students taking an Algebra 11 preparatory course felt they were above average in mathematics, compared to only 14% from the alternate course. Since a large majority of university-bound students take Algebra 11 as a prerequisite course, it is not unusual to find a larger proportion in this group who feel they were above average. At the other end of the scale, however, there is little difference. Eleven percent of the pre-Algebra 11 group felt they were below average, compared to 14% of the other group.

Performance, reported as subtest means, by course category is reported in Table 6-34. Students enrolled in the Algebra 11 preparatory course scored significantly higher on all three subtests. It is not surprising that students in this course category scored 18 points higher on the Problem Solving subtest since these items measure mathematical ability at a high cognitive behaviour level. However, since most alternate courses stress computation and direct applications, differences of 19 and 25 percentage points respectively on the Computation and Word Problems subtests is greater than expected.

Table 6-34
Subtest Means by Type of Course
(Percent)

Subtest	Pre-Algebra 11	Alternate Course
Computation	82	63
Word Problems	73	48
Problem Solving	70	52

Summary

The Q-Forms were designed to obtain information on how students approach and solve items presented in open-ended format. Two forms at each grade level were used, one to investigate computation and problem solving, the other to assess different topics at each grade level. About one thousand students at each grade level responded to the Q-Forms. The obtained sample of students was demonstrated to be of a higher ability than the general population.

Form Q-1

Students in Grade 4 were adept at producing appropriate word problems to match a given number combination. They were less successful in selecting an appropriate computational procedure, given a word problem. The concepts of multiplication and division were the most difficult. A sizable minority of students have problems with reversal of digits in the operations of subtraction and division. Students in British Columbia generally outperformed those in Britain upon whom the original study was based.

Students in Grade 7 were evaluated as to their ability to use a ruler and protractor. The results indicated that about half the students used each instrument at some time during the school year. Confusion as to proper units of linear measure were evident, and only about half the students could correctly measure an angle using the protractor. Considering that the sample was of higher ability than the population, the overall performance cannot be considered satisfactory.

Students in Grade 10 were evaluated on their understanding of basic concepts and processes in algebra. Performance was generally good, and students outperformed students at the same age level in the English study. However, other studies in British Columbia have shown that the study of algebra is stressed in Grade 10 almost to the exclusion of other mathematical topics such as geometry and consumer mathematics. It may be that less time could be spent on algebraic manipulations and more emphasis placed on fundamental concepts and topics which integrate algebra with geometry and measurement.

Form Q-2

Performance at all grade levels on the Computation subtest was good. In general, students who could perform routine calculations were also able to solve simple word problems using similar computations. There was no apparent pattern in the relative difficulty of word problems and computational items. In some cases a word problem may provide an appropriate context which helps the student to carry out the computation. In other cases, the setting of the problem may obscure the required calculation.

On the Problem-Solving subtest, in which the problems could not be solved by applying simple computational algorithms, students were less successful at all grade levels. The lack of alternate problem-solving strategies was evident, except at Grade 7 where many students drew a diagram to help in the solution. Teachers need to encourage students to break away from reliance on the "set up an equation" strategy to solve problems.

Differences in performance by gender were very small, but boys tended to perceive their mathematical ability more positively than did girls. In Grade 10, it was clear that students in courses designed as preparation for Grade 11 were much superior to others both in performance and in self-perception of ability.

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CHAPTER 7

TEACHERS OF MATHEMATICS

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With respect to teacher questionnaires, the 1985 Mathematics Assessment differed from those in 1981 and 1977 in one basic way. In previous Assessments, the teacher questionnaires covered a broad range of topics and were administered to a sample of teachers drawn from across the elementary and secondary grades. In 1985, only teachers of those classes which were being assessed were polled, and the results for 1985 are, therefore, based on a large sample of teachers of Grades 4, 7, and 10.

Some comparisons with the 1977 and 1981 results are reported in this chapter, and the differences in sampling should be borne in mind. In 1977, questionnaires were administered to teachers of Grades 1, 3, 5, 7, 8, 10, and 12, and some information was reported for teachers at each of those grade levels. Therefore a direct comparison between teachers of Grades 7 and 10 in 1977 and 1985 is possible. In 1981, however, the sample of teachers was stratified by grade level, and the results were reported for only two groups: elementary and secondary. Therefore, it is not possible to draw exact comparisons between the results in 1981 and 1985. If the Grades 4 and 7 teachers in 1985 are assumed to be representative of elementary teachers, and if Grade 10 teachers are representative of secondary teachers, then some limited comparisons may be drawn.

In 1977 the questionnaire return rate varied from 80% to 85%, depending on grade level. In 1981, the return rate was 75% for elementary and 77% for secondary. In both those Assessments it was possible to determine the exact return rate because questionnaires were mailed out to a particular number of teachers, randomly selected. In 1985, however, the teacher questionnaires were included as part of the administrative package for teachers whose classes were writing the Assessment. It was not possible, therefore, to determine the precise numbers of teachers of mathematics surveyed at the three grade levels in 1985, because some teachers, particularly at the Grade 10 level, teach more than one mathematics class.

The 1985 teacher sample was much larger than those obtained in previous Assessments. In 1977, 521 responses were used at the Grade 3 level, 530 at the Grade 7 level, and 292 at the Grade 10 level. In 1981, the elementary results were based on 868 completed questionnaires; and the secondary results, on 733. In the 1985 Assessment, the return rates were 1304 at the Grade 4 level, 1044 at the Grade 7 level, and 686 at the Grade 10 level. Thus the information for 1985 is based on much larger numbers of teachers, but on fewer grade levels.

Structure of the Questionnaires

Each questionnaire consisted of four distinct sections: Background Information, Mathematics in School, Problem Solving, and Calculators and Computers. In the Background Information section, teachers were asked for information about their preparation for teaching mathematics, the frequency and length of mathematics periods for the class they taught, and specific activities in the classroom. The items were identical at each of the three grade levels.

The items in the Mathematics in School section were identical to those contained in the student booklet, Form R, at each grade level. These items concerned activities and topics specific to each grade level, and teachers were asked to rate each in terms of its importance for the class, how easy teachers felt the topic was to teach, and how much they enjoyed teaching the topic. This section was based on a scale developed for the Second International Mathematics Study (Robitaille, O'Shea, & Dirks, 1982). Students and teachers responded to identical items, and it is therefore possible to compare their opinions.

The third section, Problem Solving, was included to ascertain teachers' attitudes toward problem solving, and to obtain information on teachers' practices in teaching problem solving. The items were identical across the three grade levels.

The fourth section was entitled Calculators and Computers. Teachers were asked for information on their personal use of calculators, and the extent to which they used calculators for instructional purposes. They were also asked to indicate how computers were used in their schools and in their classes for teaching mathematics. Finally, teachers' attitudes toward a number of issues regarding the use of calculators and computers were assessed. These items were identical across grade levels, and several were repeated in the student booklets, making it possible to compare teachers' and students' attitudes at different grade levels.

Teacher Background

Teachers were asked how many years of experience in teaching mathematics they had had as of June 1985. The results are shown in Table 7-1, along with the results for the same question posed in 1981.

Table 7-1
Years of Experience as a Mathematics Teacher
(Percent)

No. of years of experience	1981 Elem	1981 Sec	1985 Gr 4	1985 Gr 7	1985 Gr 10
1 - 2	13	16	6	5	7
3 - 5	17	20	14	12	14
6 - 10	30	23	24	28	17
11 - 15	19	18	24	26	21
more than 15	21	24	32	29	39
median	6-10	6-10	11-15	11-15	11-15

The figures in Table 7-1 indicate a trend toward an aging cohort of mathematics teachers at all three grade levels. This tendency is undoubtedly a reflection of the influence of a number of forces operating to reduce the number of teaching positions available. School districts are hiring fewer mathematics teachers, and those who have teaching jobs are staying on longer. The result is a large proportion of teachers at the high school level with more than 15 years of experience in teaching mathematics. This may be a mixed blessing. Mathematics at the secondary level is taught by a highly experienced group of teachers, but the absence of younger, more recently trained, graduates may make it difficult to implement the changes in the mathematics curriculum proposed for the late 1980s.

A summary of the responses to the question which asked what percent of the teacher's current teaching load was devoted to mathematics is shown in Table 7-2. Almost 50% of Grade 10 teachers had virtually their entire teaching load in mathematics. On the other hand, about one-quarter of Grade 10 teachers taught just one or two mathematics classes.

Table 7-2
Mathematics as Percent of Teaching Load

Percent of Load	Grade 4	Grade 7	Grade 10
0 - 20 %	65	62	12
21 - 40 %	32	30	14
41 - 60 %	3	4	13
61 - 80 %	1	1	11
81 - 100 %	-	2	48

Teachers were also asked how many mathematics periods their classes had each week. Results are reported in Table 7-3. At the elementary level, the usual frequency was once a day, and at the secondary level, three times a week.

Table 7-3
Number of Mathematics Periods per Class each Week
(Percent of Teachers)

Number of periods	Grade 4	Grade 7	Grade 10
3	--	2	61
4	8	8	17
5	84	74	14
6	5	13	7
more than 6	2	3	1

A third question relating to the specifics of the mathematics period asked how long each mathematics period was. Results are tabulated in Table 7-4.

Table 7-4
Length of Each Mathematics Period
(Percent)

Length (minutes)	Grade 4	Grade 7	Grade 10
30 or less	1	1	0
31 - 45	71	58	2
46 - 60	27	39	89
61 - 75	1	1	7
more than 75	--	--	1

From the information in Tables 7-3 and 7-4, it is reasonable to conclude that the typical elementary teacher teaches mathematics every day for one period of about 40 minutes. This is about one-seventh, or 15%, of the daily instructional time available. Thus, in Table 7-2, one would expect most elementary teachers to indicate 0-20% of their teaching load to be in mathematics, and this was the case. However, about a third of elementary teachers indicated 21% to 40% of their time was spent teaching mathematics. Because Grade 4 teachers typically teach only one class, the results may indicate that many may spend extra time in their class working with mathematics. At the Grade 7 level, it is more likely that the 30% of teachers who indicated that 21% to 40% of their teaching load was in mathematics are teaching more than one class of mathematics; that is, there may be some degree of specialization at this level.

As in 1981, teachers were very positive about teaching mathematics. In response to the question asking whether they would avoid teaching mathematics altogether if they had a choice, 96% of elementary teachers and 95% of secondary teachers said "No". About 2% of each group was undecided.

Professional Preparation of Teachers

A number of items concerned the level of preparation of mathematics teachers. Teachers were asked how many post-secondary courses in mathematics, and in mathematics education, they had successfully completed. Three UBC credits were assumed equivalent to two courses. Results are shown in Table 7-5, where the numbers in parentheses refer to mathematics education courses.

Table 7-5
Post-secondary Courses in Mathematics and Mathematics Education
(Percent of Teachers)

No. of courses	Grade 4	Grade 7	Grade 10
0	32(18)	23(23)	5(24)
1-2	42(68)	41(62)	16(46)
3-5	19(13)	25(13)	20(18)
6-9	4(1)	7(1)	20(7)
10 or more	3(--)	4(1)	40(5)

At the elementary level, there is a large group of teachers who have taken no mathematics or mathematics education courses. In the 1977 Assessment, teachers were asked whether they had completed at least one mathematics and one mathematics education course subsequent to high school. The 1977 results, together with comparable results from 1985, are shown in Table 7-6. The 1977 Grade 4 figures were obtained by averaging the results for Grade 3 and Grade 5 teachers. The results in Table 7-6 indicate a general trend toward increasing numbers of mathematics teachers at both elementary and secondary levels who have had no training in the teaching of mathematics.

Table 7-6
No Mathematics or Mathematics Education Courses
(Percent of Teachers)

	1977 Grade			1985 Grade		
	4	7	10	4	7	10
No math. courses	26	16	3	32	23	5
No math. ed. courses	14	17	16	18	23	24

Teachers were also asked whether they had attended a mathematics session at a conference within the last three years. About 50% of elementary teachers, and 56% of secondary teachers had done so. These figures are down slightly from previous years.

About 58% of elementary teachers and 63% of secondary teachers reported that they had attended a workshop or in-service day in mathematics, other than at a conference, in the last three years. These figures are up slightly from 1981 and are virtually the same as in 1977. Membership in professional organizations remains disappointingly low, as can be seen in Table 7-7. In this table, the 1977 results have been combined into a single grouping at the elementary level.

Membership in the three major professional organizations for mathematics teachers has remained stable, while there appears to be growing interest in the Provincial Intermediate Teachers' Association. The continued support by secondary teachers for the NCTM is gratifying. Nonetheless, 68% of elementary teachers and almost 60% of secondary teachers do not belong to any professional organization of mathematics teachers.

Table 7-7
Membership in Professional Organizations
(Percent of Teachers)

Organization	1977		1981		1985		
	Elem	Gr 10	El	Sec	Gr 4	7	10
BCAMT	3	29	1	26	2	3	27
NCTM	1	11	1	14	1	2	13
Local math. PSA	1	28	1	21	1	3	19
PITA	14	n/a	15	0	23	26	1
Primary Assn.	29	n/a	28	0	8	1	0
None of the above			57	59	68	67	59

Classroom and Course Organization

Teachers were asked to complete the next section of the questionnaire with reference to one particular class, the reference class. For teachers who taught more than one class, the first mathematics class in the week or timetable cycle was designated as the reference class. This procedure was designed to obtain information on all types of classes, whether regular, remedial, or enriched.

Teachers were asked which course organization best described the course offered to their reference class, and the results are contained in Table 7-8. About 90% of elementary teachers reported that theirs was a full-year regular program. This was to be expected, as most ability grouping at the elementary level takes place within the class rather than across classes.

At the secondary level, 18% of teachers reported teaching a semestered course. This agrees with the student results which indicated about 17% of Grade 10 students in semestered courses. About two-thirds of the Grade 10 teachers reported teaching the regular program, and about a quarter taught a course modified for slower students. Because the curriculum guide does not specify material for slower students, little is known about the content of modified courses; that is, whether they contain the same basic material as regular courses and are taught less intensively, or whether they contain different material. On the other hand, the guide does suggest material for enrichment, but again it is not clear what the enriched courses, 11% of the total, might have contained.

Table 7-8
Course and Program Organization
(Percent of Teachers)

Type of Course & Program	Grade 4	Grade 7	Grade 10
Full-year course, regular program	87	90	55
Full-year course, modified (slower students)	7	5	19
Full-year course, enriched	4	3	9
Semester course, regular program	1	0	11
Semester course, modified (slower students)	0	0	5
Semester course, enriched	1	1	2
Other	1	1	1

A series of questions was asked concerning the reference mathematics class, particularly regarding details of the last mathematics period in which this class was taught. The results concerning students' activities have been combined in Table 7-9.

Table 7-9
Students' Activities during Mathematics Class
(Percent of Teachers)

% of Time	Seatwork			Small groups			Stations		
	Gr4	Gr7	Gr10	Gr4	Gr7	Gr10	Gr4	Gr7	Gr10
None	1	1	1	57	58	60	82	91	97
1-10	4	4	5	24	26	21	14	7	2
11-25	19	24	22	11	9	11	3	1	0
26-50	49	44	41	5	4	4	1	1	0
51-75	22	22	26	1	1	2	0	0	0
76-100	5	4	6	2	2	2	0	0	0

Students' activities were surprisingly similar across grades. Typically, students were engaged in individual seatwork about 40% of the time, regardless of grade level. About 60% of teachers at all grade levels reported that they never had students work in small groups, while about one-third said that students worked in small groups up to about one-quarter of class time. Stations and activity centres were used more in the lower grades, but even at the Grade 4 level, over 80% of the teachers did not use these teaching approaches.

Typical activities of teachers were also classified and the amount of time devoted to each was determined. The results, as shown in Table 7-10, are what might be expected given the nature of teaching and the curriculum at the various levels. Homework assumes greater importance with increase in grade level. Computational drill is seen to be important, but less so at the upper grade levels. However, even in Grade 10, about one-quarter of teachers still do some computational drill.

Table 7-10
Teachers' Activities during Mathematics Class
(Percent of Teachers)

Percent of Time	Discussing Homework			Supervising Computational Drills			Explaining New Topics		
	Gr4	Gr7	Gr10	Gr4	Gr7	Gr10	Gr4	Gr7	Gr10
None	24	8	6	26	51	77	16	12	11
1-10%	53	46	36	56	39	17	23	19	15
11-25%	20	37	50	12	7	4	42	45	44
26-50%	3	7	6	3	2	2	16	21	25
51-75%	0	2	2	2	1	0	3	2	5
76-100%	1	1	0	1	0	0	1	1	1

Teachers were also asked how often they gave tests or quizzes in mathematics. Virtually all gave tests at least "once every couple of weeks". The frequency of testing decreased with increasing grade level.

Finally, teachers were asked at what level students should first be taught mathematics by someone who specializes in the teaching of mathematics. Results are contained in Table 7-11.

Table 7-11
Level Suggested for Mathematics Teaching Specialists
(Percent of Teachers)

Level	Gr 4	Gr 7	Gr 10
At no level	2	1	1
Primary	21	17	28
Intermediate	19	26	41
Junior Secondary	55	52	27
Senior Secondary	3	4	3

Secondary teachers felt that mathematics specialists should be involved early in the school program, particularly at the intermediate level, and this is similar to results obtained in 1981. A surprising proportion of teachers at all three grade levels felt that specialists should be used at the primary level. It is possible that teachers have different interpretations of what constitutes someone who specializes in the teaching of mathematics. A secondary person might view that as someone with a strong mathematics background, whereas an elementary teacher might feel that training in one or more specialized programs such as Math Their Way is sufficient qualification.

Mathematics in School

On the *Mathematics in School* scale, ten topics from the curriculum at each grade level were listed. Teachers were asked to indicate on a 5-point scale how important they felt each topic was, how easy it was to teach, and how much they enjoyed teaching it. Possible responses ranged from not at all important to very important; very difficult to very easy; and dislike a lot to like a lot. For reporting purposes the responses on each scale have been grouped into three categories: negative, undecided, and positive.

Students at each grade level also responded to the same ten items. The students were instructed to tell, "How important you think the topic is;" "How easy it is;" and "How well you like the topic." Although the student results have been reported in Chapters 3, 4, and 5, they are repeated in this chapter, in order to compare teacher and student responses.

Grade 4

Results for the ten topics are shown in Figure 7-1. The topics were as follows:

1. Adding, subtracting, multiplying and dividing whole numbers
2. Learning about decimals
3. Learning about fractions
4. Learning the metric system
5. Learning how to estimate
6. Learning about squares, rectangles, and triangles
7. Checking answers by going back over them
8. Using graphs
9. Solving word problems
10. Learning about place value

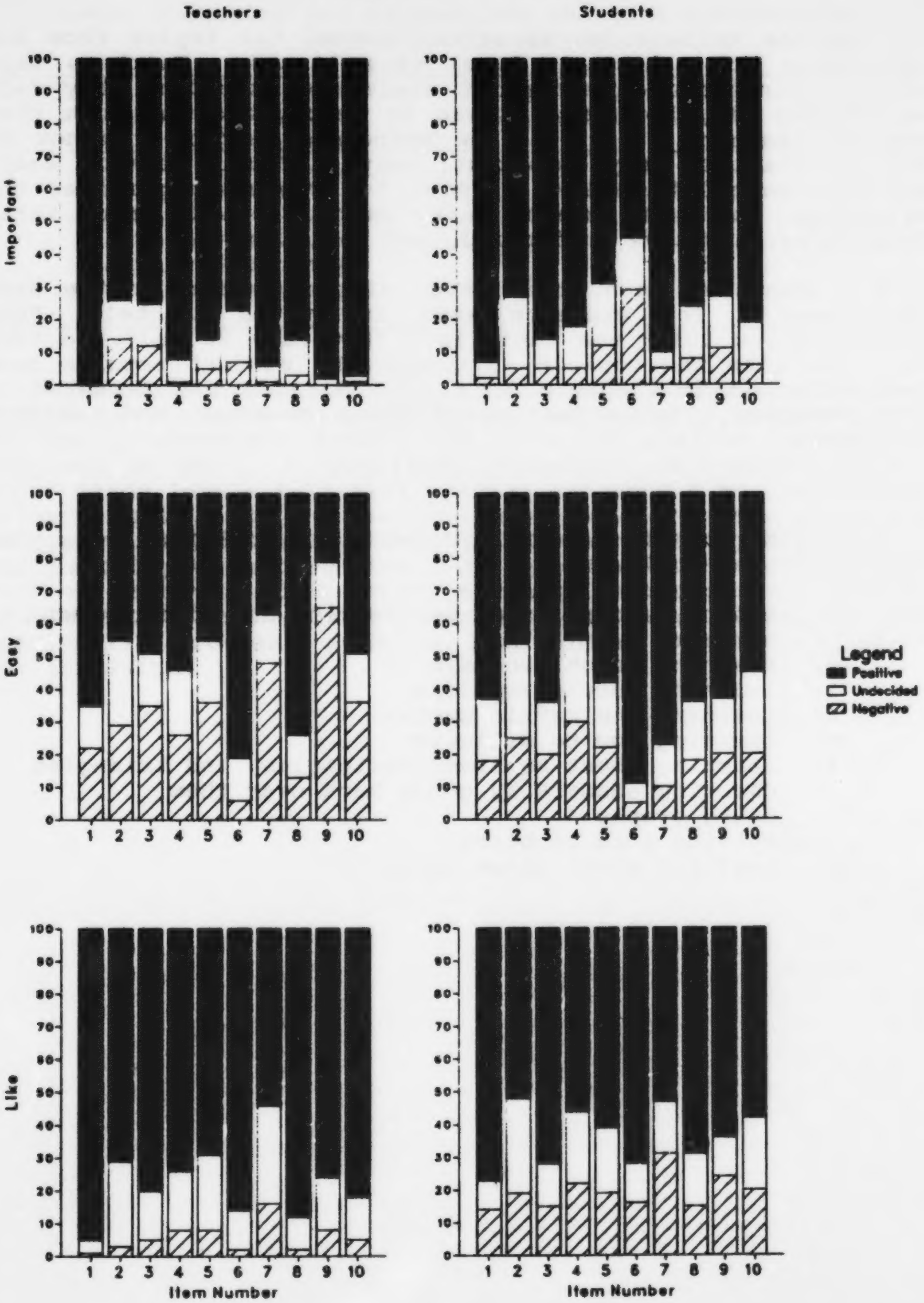

Figure 7–1. Mathematics in School: Grade 4.

Teachers indicated that all of the topics listed were important. The least important were learning about fractions, learning about decimals, and learning about squares, rectangles, and triangles. There were relatively few responses at the extremely positive end of the three scales. For example, more teachers rated every topic easy than very easy. The only exceptions occurred on the importance scale, and the five topics rated very important were operations on whole number, learning about the metric system, checking answers, solving word problems, and learning place value. More than 50% of teachers rated these items very important, thereby indicating very definite positive opinions.

Teachers were also quite consistent in their enjoyment of each topic, with the exception of Topic 7, checking answers by going back over them. Of the ten topics, teachers liked teaching operations on whole numbers best.

There was much greater variability on teachers' responses on the easiness scale. Teachers felt that solving word problems was the most difficult of all, and only 21% said it was easy or very easy. The other difficult topic was getting students to check answers. The two easiest topics were teaching about squares, rectangles, and triangles; and using graphs.

The students responded in a pattern similar to that of the teachers. However, they tended to view the topics as a little less important and somewhat more difficult. They also liked them less. Students felt that Topic 6, the only geometric topic, was the least important, and the easiest. It was one of the most liked activities.

Students and teachers differed most on Topic 9, solving word problems. Students saw it as much less important than teachers. They reported it to be much easier to learn, and they liked it less than teachers. If the revised mathematics curriculum for British Columbia is to be accepted by students, teachers should stress the importance of problem solving and take advantage of students' apparent lack of animosity toward the topic.

Grade 7

Results for the ten topics are shown in Figure 7-2. The topics were as follows:

1. Adding, subtracting, multiplying and dividing fractions
2. Adding, subtracting, multiplying and dividing decimals
3. Working with percents
4. Learning about estimation
5. Memorizing basic facts
6. Solving equations
7. Solving word problems
8. Learning about the metric system
9. Working with perimeter and area
10. Doing geometry

Teachers viewed all of the topics as important. The least important was doing geometry, and more teachers were undecided on this item, 23%, than on any other item. On four topics, more than 50% of teachers gave a very important rating: operations on decimals, working with percent, memorizing basic facts, and solving word problems. Of these, the highest rating was given to operations on decimals, followed by solving word problems.

Generally, teachers said they liked teaching these topics. They were least favourably disposed toward teaching basic facts. About 70% reported that solving word problems was a difficult topic to teach. The next most difficult was solving equations, which about 50% rated difficult to teach.

Students, in general, rated all topics less important, easier, and less enjoyable than the teachers. On the importance scale, students disagreed most with teachers on the topics of estimation and solving word problems. Only 53% thought estimation was important, compared to 85% of teachers. Sixty percent of students rated word problems important compared to 96% of teachers, 62% of whom felt the topic to be very important. Students tended to see the collection of topics related to number operations and algebra as the most important component of the curriculum.

Students were quite constant in their view of the easiness of the topics, with problem solving, measurement, and geometry rated somewhat more difficult than the others. They liked solving word problems least, but differences were not great.

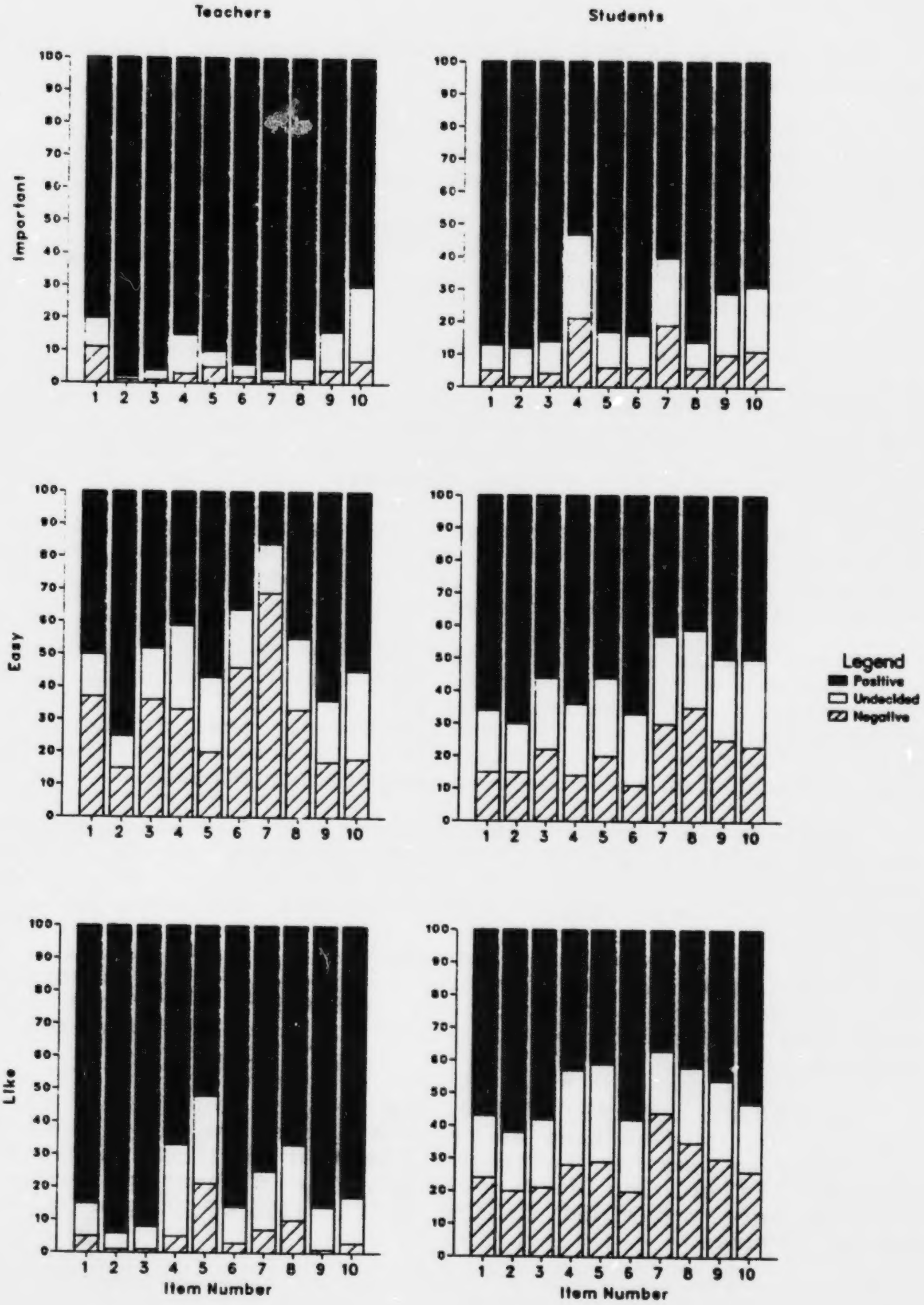

Figure 7–2. Mathematics in School: Grade 7.

Grade 10

The results on the ten topics are shown in Figure 7-3. The topics were as follows:

1. Solving equations
2. Finding area and volume
3. Working with fractions, decimals and percent
4. Factoring
5. Constructing geometric figures
6. Working with exponents
7. Constructing graphs
8. Estimating answers
9. Solving word problems
10. Working with congruent and similar figures

Teachers rated most topics as important. The two notable exceptions were constructing geometric figures, and working with congruent and similar figures. These items also drew the largest proportion of undecided teachers, about 30%. As these two items were the only ones related to geometry, it may be that teachers do not consider geometry to be an important part of the curriculum. The most important topics were solving equations and solving word problems, and over half the teachers rated these as very important.

Most teachers liked teaching each topic, and the favourite was solving equations. The least liked topics dealt with geometry and numerical computation. The most difficult topic to teach was solving word problems, rated difficult or very difficult by 76% of teachers. Teachers were also the least undecided on this topic as compared to others.

Students concurred with teachers in viewing solving equations and working with fractions, decimals and percents as important topics. They also rated finding area and volume important. They agreed with teachers on the relative unimportance of geometric topics. They saw the remaining five topics as much less important than did the teachers. Of particular note was the difference in opinion on factoring, which students did not consider important. Students also downplayed the importance of solving word problems compared to teachers.

Students uniformly liked the topics less than their teachers, but viewed them as being of about the same level of difficulty to learn as to teach. The most difficult topic for students was solving word problems. The highest percent of students were undecided on the difficulty of congruent and similar figures.

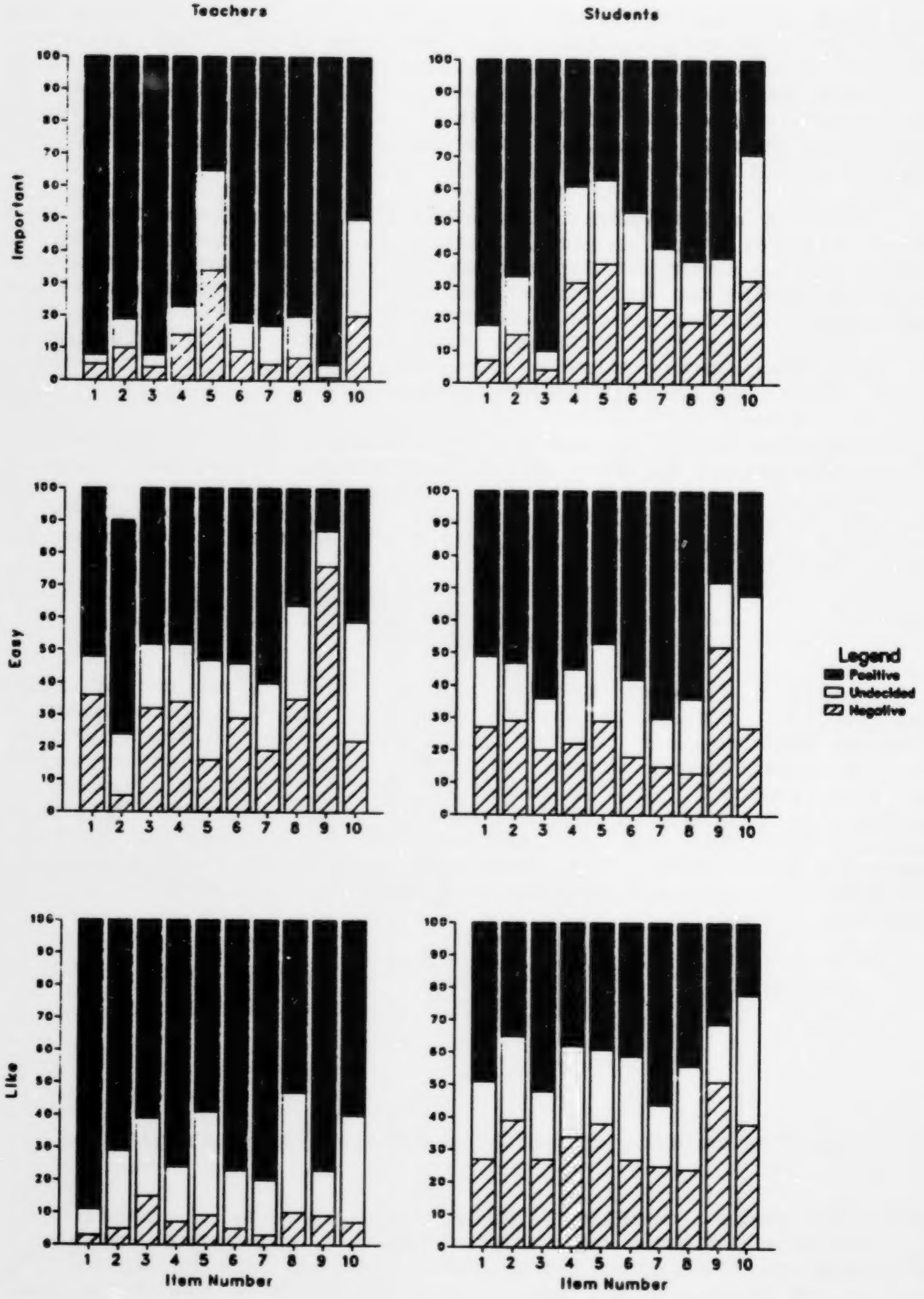

Figure 7–3. Mathematics in School: Grade 10.

Summary

Teachers at the upper grade levels tended to rate the group of topics presented as less important than at lower levels. Geometric topics were consistently rated as important by fewer teachers at all grade levels, and the degree of importance decreased with grade level. On the other hand, geometric topics were not seen as particularly difficult to teach, or disliked.

Grade 4 and Grade 7 students' ratings of importance were quite similar, but Grade 10 students were more negative in their view of the importance of the topics presented. Students seemed to be consistent in their attitudes toward the difficulty of the topics, and an average of 40% to 50% at each grade level reported the topics to be easy. Students tended to show increasing dislike for the topics with increasing grade level.

The one topic on which teachers were agreed was solving word problems. At each grade level this topic was seen by teachers to be very important and very difficult to teach, but not particularly disliked. Grade 7 students, and Grade 10 students in particular, found the topic difficult and they did not like it.

Problem Solving

Scale S in each booklet consisted of a number of items designed to obtain teachers' opinions on their teaching of problem solving, and the resources available for that purpose. On the first seven items, teachers expressed their agreement or disagreement, on a 5-point scale, with a number of statements concerning their own and their students' views of problem solving, and the adequacy of textbooks and district resource materials. The remaining nine items were structured to obtain information on teaching practices related to problem solving.

Teacher Opinions on Problem Solving

Teachers were asked to what extent they agreed with a number of statements on problem solving. Their responses have been classified as negative, neutral, and positive, and the results are reported in Figure 7-4. For each item the three bars represent grades 4, 7, and 10. About 2% of teachers strongly agreed across the items, with the exception of Item 5, 5%, and Item 6, 11%. The percentage of teachers who strongly disagreed ranged from 5% to 10%, except for Item 3, 30%, and Item 5, 2%. The items were as follows:

1. Most of my students enjoy problem solving.
2. Most of my students perform well in problem solving.
3. The textbooks I use provide adequate instruction for developing problem-solving skills.
4. My district provides adequate assistance and resources for the teaching of problem solving.
5. I am satisfied with my teaching of problem solving.
6. All mathematics teachers should attend at least one workshop on problem solving each year.
7. It is easy to teach problem solving.

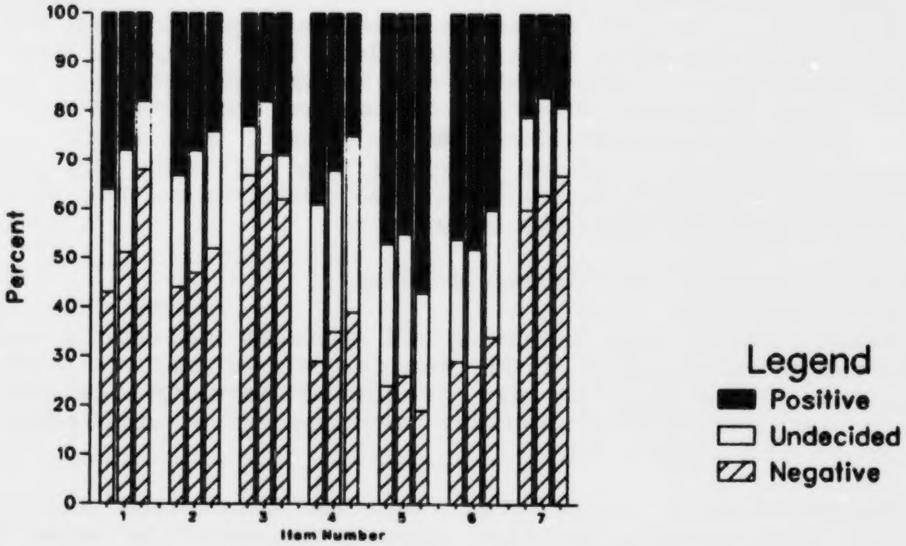

Figure 7-4. Teacher opinions on problem solving

Items 1 and 2 dealt with teachers' views of their students' enjoyment and performance in problem solving. At all grade levels teachers were more negative than positive, and there was a trend on both items for teachers to be more negative at higher grade levels. At Grade 10, only 18% of teachers felt that most students enjoyed problem solving, and 24% felt their students performed well.

Items 3 and 4 were used to determine the adequacy of resources for teaching problem solving. Across all seven items, about one-quarter of the teachers were undecided, but on Item 3 only about 10% of teachers were in this category. Most were very definite that the textbooks were inadequate, and this is shown by the relatively high 30% of teachers who strongly disagreed with the statement.

More teachers were undecided on Item 4 than on any other item. The degree of satisfaction that teachers have with the assistance and materials at the district level is highest at Grade 4 and lowest at Grade 10. Even at Grade 4, only 39% of Grade 4 teachers saw district resources as adequate.

Items 5 and 7 were concerned with the teachers' personal outlook on problem solving. About half were satisfied with their own teaching of the topic, but few found it easy. Levels of satisfaction seemed to be somewhat less in elementary school than at Grade 10.

About half the elementary teachers were agreed that teachers should attend an annual workshop on problem solving. Grade 10 teachers were more undecided, but favoured the idea. On the other hand, when asked how many workshops on problem solving they had attended in the past year, about 75% of teachers at each grade level said "none", and about 20% had attended only one. These figures may reflect the lack of availability of such workshops, and underscore the need for in-service training in this area.

Teaching Practices in Problem Solving

Questions on the teaching of problem solving covered a broad range of topics from sources of ideas to types of evaluation. The results are presented here in the order in which a teacher might consider setting up a problem-solving program in the classroom.

Teachers were asked what sources they used to provide students with problem-solving exercises, and the results are shown in Table 7-12. The textbook is the dominant source, and mathematical contests become increasingly important at higher grade levels. Problem-solving booklets are popular at all levels, particularly in the elementary school. The use of sources other than the textbook would seem to be necessary in view of the dissatisfaction with textbooks expressed by teachers in the section on teachers' opinions.

Table 7-12
Sources of Problem-Solving Exercises
(Percent of Teachers)

Source	Grade 4	Grade 7	Grade 10
Textbook	95	95	94
Mathematical contests	25	38	40
Problem-solving booklets	73	68	54
Professional journals	19	19	17
Books of puzzles	64	59	42

The issue of how to motivate students to participate in problem-solving activities was addressed in Item 11, and results are shown in Table 7-13. The most popular motivator at all levels was the use of puzzles or brain teasers. Competitive games were popular at Grade 4 but such activities decreased with increasing grade level. In the lower grades, the term "contests" may not have been readily interpretable. It was intended that these refer to organized external competitions such as the Gauss or Euclid contests.

Table 7-13
Activities Used to Motivate Students
(Percent of Teachers)

Activity	Grade 4	Grade 7	Grade 10
Competitive games	43	38	14
Problem of the day or week	37	39	29
Puzzles or brain teasers	78	76	48
File of interesting problems	31	29	30
Contests	27	30	30

In a similar vein, teachers were asked about the kinds of problem-solving activities they set up in class (see Table 7-14). Elementary teachers seemed to provide a richer atmosphere for problem solving than their secondary colleagues. Activities such as having students make up problems for others to solve might profitably be incorporated into the secondary classroom. A problem-solving centre might be combined with a bulletin board display as a focal point in the classroom.

Table 7-14
Problem-solving Activities in Class
(Percent of Teachers)

Activity	Grade 4	Grade 7	Grade 10
A problem-solving centre	15	11	4
A bulletin board display	11	11	12
Problem of the week	26	28	21
Problem-solving contests in class	36	41	22
Students make up problems	51	40	17

One of the themes of the new approaches to problem solving stresses the need for students to be exposed to problems which require more than just a simple calculation. Teachers will be expected to present problems which have too much or too little information, or have more than one solution, or which can be solved in a number of different ways. Teachers were asked about the kinds of problems they assigned, and the results are shown in Table 7-15. The variety of problems assigned, and the widespread use of problems which can be solved in more than one way, is very encouraging.

Table 7-15
Types of Problems Assigned to Students
(Percent of Teachers)

Type	Grade 4	Grade 7	Grade 10
Problems with more than one correct answer	34	34	38
Problems which require students to collect information	63	59	47
Problems which can be solved in more than one way	76	89	87
Problems which students work on collectively in groups	38	43	31
Problems with either too much or too little information	43	64	42

Following the previous item, the question arises as to what problem-solving strategies teachers encourage in their classes. If students are encouraged to attempt problems which can be solved in more than one way, they may require specific which asked teachers to indicate which common strategies they taught are shown in Table 7-16. In the elementary grades, the dominant approach was to look for a pattern, while the use of a systematic list or table was highest in Grade 10.

Two approaches which were not used as frequently were guess and check, and work backwards. The intelligent use of guess and check is a powerful heuristic and, coupled with estimation, should be emphasized. If the strategy of working backwards were taught in school, students' performance on multiple-choice items, such as on the Mathematics Assessment, might likely improve.

Table 7-16
Problem-solving Strategies Taught
(Percent of Teachers)

Strategy	Grade 4	Grade 7	Grade 10
Look for a pattern	85	85	77
Guess and check	38	43	30
Make a systematic list or table	63	71	81
Solve a simpler problem	63	72	66
Work backwards	38	46	29

Evaluation of the achievement of students on problem-solving activities is always a problem. If the process of problem-solving is worth teaching, it should be worth something when students are evaluated, and the results in Table 7-17 show that about 95% of teachers did give partial credit for work toward a solution. Most teachers, from 70% to 90%, gave marks to students who produced an appropriate diagram or equation, or showed a correct procedure. This tendency was particularly noted among Grade 10 teachers.

Table 7-17
Results for which Teachers gave Marks
(Percent of Teachers)

Results	Grade 4	Grade 7	Grade 10
No partial credit	6	6	3
Appropriate diagram or equation	72	76	90
Procedures used	87	88	95
Final answer	86	88	91
Check the answer	25	21	36

Teachers were asked about the way in which they set aside time for teaching problem solving, and the results are shown in Table 7-18. At the elementary level, problem solving was viewed as a regular part of the curriculum, while Grade 10 teachers typically taught it as a unit on an irregular basis. The organization of problem-solving time reflects the organization of textbooks, and results on items discussed earlier showed that virtually all teachers use the textbook as a source of problems.

Table 7-18
Organization for Problem Solving
(Percent of Teachers)

Method	Grade 4	Grade 7	Grade 10
As a unit from time to time	21	24	47
Almost every day, as a regular part of the mathematics class	35	38	29
One period every 2 or 3 weeks	11	6	3
At the end of a major topic or chapter	15	18	18
One period a week	18	14	4

Summary

Problem solving will be an important component of the revised mathematics curriculum in British Columbia. At the present time, teachers report that they find it difficult to teach problem solving, and that their students neither enjoy it nor are very successful at it. Teachers are dissatisfied with their textbooks, and they report that district resources for teaching problem solving are inadequate. Only 20% of teachers had attended a workshop in problem solving within the last three years.

Calculators and Computers

Scale T in each booklet consisted of a number of items designed to obtain information on teachers' attitudes toward and use of calculators and computers in the classroom.

Calculators

Almost all teachers own calculators: 91% at Grade 4, 96% at Grade 7, and 97% at Grade 10. About 80% of Grade 10 teachers used their calculators outside of school at least several times a week, and these figures were 70% for Grade 7 teachers and 55% for Grade 4 teachers. Thus, teachers are familiar with calculators and use them in their own lives.

Teachers were also asked in what ways they used calculators for non-instructional school work. Eighteen percent of Grade 4 teachers, 8% of Grade 8, and 5% of Grade 10 reported that they did not use them at all for this purpose. The most frequent use was to calculate students' grades, ranging from 77% of Grade 4 teachers to 92% in Grade 10. Overall, use increased with grade level. About one-third of Grade 4 teachers used them to check students' answers and to prepare worksheets, whereas two-thirds of Grade 10 teachers used them for such purposes.

On the other hand, 57% of Grade 4 teachers, 35% of Grade 7 teachers, and 15% of Grade 10 teachers did not allow students to use calculators in class. About one-third of Grade 4 teachers and two-thirds of Grade 10 teachers permitted their use. In 8% of Grade 4 classes, calculators were provided for the students, and in 11% of Grade 10 classes, each student had to supply his or her own.

In classes where the use of calculators was permitted, Grade 4 students used them mainly for drill and practice to enhance computational skills, while Grade 7 and 10 students used them mainly to work on problems. In about half these classes at each grade level, students used calculators for estimating and finding patterns.

One item was designed to compare students' and teachers' views as to the legitimacy of using calculators in schools. As can be seen in Table 7-19, Grade 4 teachers felt that students should not use calculators in school, and this result is in close agreement with the proportion of teachers who did not permit calculators in their classsroom. At Grades 4 and 7, students were more opposed than their teachers to the use of calculators in school. At Grade 10, the opinions of students and teachers were quite close, with about 75% of each group favouring calculators in school.

Table 7-19
Opinions on the Use of Calculators in School
(Percent of Teachers and Students)

Item: "Some people say that Grade 4 [7,10] students should not be allowed to use calculators in school. How do you feel about this?"

Response	Grade 4		Grade 7		Grade 10	
	T	S	T	S	T	S
Strongly disagree	10	13	21	10	38	26
Disagree	25	17	36	29	36	46
Undecided	25	15	19	28	12	19
Agree	25	35	18	26	10	8
Strongly agree	14	18	6	7	4	2

The use of calculators in school is controversial because of the feeling that students will come to rely solely on the calculator for computational purposes. Some argue that this is acceptable while others maintain that students will still need to carry out pencil-and-paper algorithms. From the results shown in Table 7-20, it is clear that teachers were uniformly of the opinion that students should still have to learn basic algorithms. Students, on the other hand, were less inclined to see the algorithms as necessary, particularly in the lower grades. The question itself may have been difficult to interpret as there are various degrees to which computational algorithms can be taught.

Table 7-20
Opinion on Need to Learn Basic Skills
(Percent of Teachers and Students)

Item: "Some people say that if students are allowed to use calculators, then it is not necessary for them to learn how to add, subtract, multiply, or divide by hand. How do you feel about this?"

Response	Grade 4		Grade 7		Grade 10	
	T	S	T	S	T	S
Strongly disagree	63	28	65	41	68	56
Disagree	19	23	20	28	23	29
Undecided	6	11	5	11	3	9
Agree	8	25	6	15	4	5
Strongly agree	4	13	4	6	2	2

Computers

In this section, teachers were asked about their own experience with computers, and how they used computers to teach mathematics. They also responded to a number of items designed to assess some of their attitudes toward the uses of computers.

Teachers were asked whether they had a computer, one that would do more than play games, at home. Ownership rates for Grades 4, 7, and 10 teachers were 21%, 24%, and 34%, respectively. About 10% at each grade level had had no experience with computers. About half the teachers who did have experience obtained it on their own, and about half through special courses.

Teachers were asked what applications of computers they had experience with, and the results are shown in Table 7-21. Teachers seem to have had a wide range of experience, and the use of a computer for programming increased with increasing grade level.

Table 7-21
Teachers' Experience with Computer Applications
(Percent of Teachers)

Application	Grade 4	Grade 7	Grade 10
None	8	8	9
Games	75	75	62
Word processing	49	62	53
Computer-assisted instruction	70	75	61
Programming	36	49	67

In response to an item dealing with the type of computer organization in school, almost no one said there were no computers in the school, or that computers were used for administrative purposes only. The most common type of organization was one in which computers were provided in one or more places for use by teachers with their students: 62% of elementary teachers, and 55% of Grade 10 teachers. At the elementary level, the next most common occurrence was the presence of computers in some or all classrooms, about 22%. About 13% of elementary teachers said that computers were provided in one or more places which were staffed by specialists or resource persons. At the Grade 10 level, 33% indicated that computers were dealt with by specialists, and 11% said there were computers in some or all classrooms.

Teachers were asked how they used computers in their mathematics classes, and the results are shown in Table 7-22. The most common use was at the Grade 4 level, where almost half the teachers had their students use software packages. More than three-quarters of Grade 10 teachers did not use them to teach mathematics in any way.

Table 7-22
Use of Computers in Mathematics Class
(Percent of Teachers)

Use	Grade 4	Grade 7	Grade 10
Not used	50	51	78
By teacher to demonstrate concepts	10	13	8
Students learn computer programming	12	19	7
Students use software packages	47	9	12
By teacher for record-keeping	10	15	15

On another item teachers were asked about the kinds of software their students used for learning mathematics. At the elementary level, the most popular form was drill and practice, closely followed by educational games. About half as many teachers used the computer in a tutorial mode to teach a skill or concept, and fewer yet used it to simulate a real situation. At the Grade 10 level, computers were used about equally across all four applications.

When asked which group of students in their mathematics classes made the most use of computers in school, half the elementary teachers said all children used them equally. Teachers did report a tendency for higher ability students to make more use of computers as grade level increased.

Teachers were asked to respond, on a 5-point scale from "strongly disagree" to "strongly agree", to the following attitudinal items:

15. If we allow computers to be used in school, they may take over some of the major functions of teachers.
16. The computer software that is available for teaching mathematics is appropriate and well-designed.
17. Students have an opportunity to be creative when they are taught mathematics by computer.
18. More boys than girls seem to use computers for doing mathematics.
19. It is essential that computers become an instructional tool for all teachers of mathematics.
20. To be successful in modern society, nearly everyone will need computer skills.

The results for teachers at the three grade levels are shown in Figure 7-5. For each item, the responses for Grades 4, 7, and 10 are shown from left to right.

The most definite view was indicated on Item 15, where almost 80% of teachers felt that computers will not take over some of the major functions of teachers in school. Teachers were generally undecided about the quality of computer software for teaching mathematics, but there was increasing dissatisfaction with increasing grade level. Teachers were also undecided about whether computers offered students the opportunity to be creative when they were taught mathematics. Perhaps this was a reflection of the unsatisfactory nature of the available software.

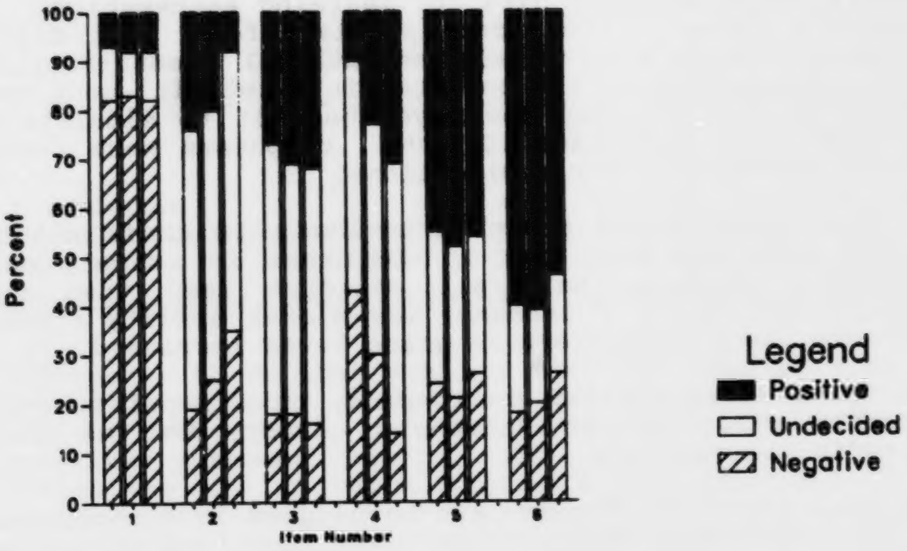

Figure 7-5. Teacher opinions on computer use.

Although there was a great deal of uncertainty about the use of computers by boys relative to girls, teachers at upper grade levels perceived more boys than girls to be using computers, and this may, indeed, reflect the reality of practice in school. About half the teachers at all levels believed it essential that computers become an instructional tool in mathematics. Moreover, about 60% believed that nearly everyone will need computer skills to be successful in society.

Summary

Most teachers own calculators and use them for non-instructional school work and in their personal lives. Fifty-seven percent of Grade 4 teachers, 35% of Grade 7 teachers, and 15% of Grade 10 teachers did not permit students to use calculators in their mathematics classes. At the elementary level, students were more opposed than their teachers to the use of calculators in school, but in Grade 10, about three-quarters of each group approved.

About one-quarter of teachers own a computer, whereas about 10% have had no experience with computers. About half the elementary teachers and one-quarter of Grade 10 teachers used computers in their mathematics classes. The greatest use at the Grade 4 level was having students use software packages, but teachers were uncertain about the quality of available software. About half the teachers felt it was important for teachers to use the computer as an instructional tool for teaching mathematics.

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234
Teachers of Mathematics

CHAPTER 8

CONCLUSION AND RECOMMENDATIONS

David F. Robitaille *Thomas J. O'Shea*

A project as comprehensive as this Mathematics Assessment produces many findings. Some of these are more important than others, and deserve special comment. The members of the Contract Team have considered the findings at each grade level in detail, and have reached a number of conclusions about the state of mathematics education in British Columbia at this point in time. The goal of the present chapter is to present a number of recommendations to those persons whose responsibility it is to see to the continuing improvement of the teaching and learning of mathematics in the schools of this province.

The 1985 Mathematics Assessment was structured along very much the same lines as the ones conducted in 1977 and 1981, and many of the findings have a familiar ring. There is a certain sense of déjà vu about many of the findings and, consequently, about the recommendations as well. It might be appropriate now, in view of the experience gained over the past three Mathematics Assessments, to re-examine the goals and objectives of these large-scale evaluation projects to ensure that they are still viable.

In both the 1977 and 1981 Assessments, specific recommendations were directed at areas which were considered to need improvement. Many of those same areas have been identified once more in 1985, and there is some doubt whether any action has been taken in the interim or not. If Assessments are to be of some help in improving the educational system, and if the large amounts of money expended on them are to be justifiable; then recommendations should be acted upon, or the reasons for not taking action should be made clear.

It must be acknowledged that the 1981 report was written in anticipation of the more or less imminent introduction of a revised mathematics curriculum, K-12. We find ourselves now, in late 1985, with the same curriculum we had in 1981 and, in fact, the same one we had in 1977. The Contract Team understands that it is difficult to implement recommended changes in emphasis or pedagogical approach in the context of an existing curriculum. Teachers are still using the same authorized textbooks, and must rely on their own devices if they are to make changes. We are hopeful that the new curriculum, soon to be introduced, will incorporate many of our recommendations, particularly those which have been made more than once.

In the 1985 Mathematics Assessment, booklets consisting mainly of open-ended items are utilized. This innovation has, in the opinion of the Contract Team, proved to be a rich source of data, much of which is still being analyzed. The goals of the assessment program might be better served, in future Assessments, by placing greater emphasis on this type of evaluation.

RECOMMENDATION 1

We recommend that the Ministry of Education re-examine the goals and objectives of the Learning Assessment Program, and that the use of evaluation strategies designed to assess the cognitive processes utilized by students be considered for inclusion in all future assessments.

The Contract Team is concerned about students' performance in geometry and about teachers' and students' rating of geometry as the least important of the topics on the *Mathematics in School* scale. We understand and expect that geometry will play a more prominent role in the revised curriculum, and we are hopeful that teachers will be provided with the materials they need to teach this geometric content well.

RECOMMENDATION 2

We recommend that increased emphasis be given to the study of geometry at all grade levels, and that in-service programs in the teaching of geometry be made available to teachers.

Results from the *Metric Usage* scale show that, in several practical situations, the majority of students at all three grade levels continue to use imperial units of measure rather than SI metric ones. Moreover, achievement results in the measurement domain reveal a degree of weakness in students' ability to convert from one unit to another within the metric system.

RECOMMENDATION 3

We recommend that teachers in all subject areas make a determined effort to use metric units exclusively in their teaching, and that conversion of units within the metric system be given increased emphasis.

We further recommend that the Ministry of Education use its influence and good offices with other governmental agencies and departments to ensure that the metric system of measurement is used exclusively in business and consumer applications.

In the 1981 Assessment it was found that teachers, particularly at the lower grade levels, were making little use of calculators or computers. A recommendation was made at that time that the question of calculator and computer use in schools be treated as a priority matter, but little appears to have been done. The situation in the schools in 1985 appears to be very much the same in this regard.

RECOMMENDATION 4

We recommend that, in the forthcoming revision of the mathematics curriculum, emphasis be given to appropriate uses of calculators and computers in the teaching of mathematics, and that a computer literacy program, separate from the mathematics curriculum, be developed and implemented for Grades K-12.

At all three grade levels assessed, results showed that students have difficulty dealing with concepts and operations involving common and decimal fractions. All of the Interpretation Panels in 1981 and 1985 referred to this problem, and a recommendation for increased attention to this area was made in 1981. The situation appears not to have changed in the interim.

RECOMMENDATION 5

We recommend, therefore, that the Curriculum Revision Committee pay particular attention to the development of rational number concepts and of computational skills with rational numbers expressed either as common or as decimal fractions. We recommend, in particular, that decimal concepts and operations be introduced in the lower grades before the corresponding work with common fractions, in order that teachers may take advantage of students' knowledge of place-value concepts with whole numbers.

Students' performance on the *Problem Solving* domain indicates that their ability to solve non-routine problems is in need of improvement. This situation is not surprising, since problem solving of this type is not explicitly included in the current curriculum guide, nor is it featured to any degree in most of the textbooks currently in use.

RECOMMENDATION 6

We recommend that the development of skills and strategies to used in solving non-routine problems in mathematics be a major focus of the revised curriculum at all levels. We further recommend that supplementary materials for the teaching of problem solving be made available for teachers for use with their students.

In both the 1977 and 1981 Mathematics Assessments it was pointed out that many teachers who had little or no background in post-secondary mathematics or mathematics education were teaching mathematics. If anything the situation in 1985 is worse than it was in 1977, and it is imperative that steps be taken to remedy this situation immediately. It will not be possible to implement the new curriculum successfully unless the teachers involved have adequate academic and professional preparation.

RECOMMENDATION 7

We recommend that principals and school district personnel ensure that, regardless of grade level, only those teachers who have adequate preparation, both academic and professional, be permitted to teach mathematics. We also recommend that all Faculties of Education in British Columbia include, as compulsory components in their teacher education programs for prospective elementary teachers, a course in mathematics and one in methods of teaching mathematics.

Appendices

APPENDIX A
CONTRIBUTORS TO THE REPORT

Les Dukowski is a Vice-Principal and teacher of mathematics at Aldergrove Secondary School in Langley. He served on the Contract Team for the 1981 Mathematics Assessment.

Wendy Klassen is a teacher at Kingwood Elementary School in Richmond. She is the elementary representative on the executive of the B.C.A.M.T. and co-author of a series of mathematics textbooks for elementary school.

Tom O'Shea is an Assistant Professor in the Faculty of Education at Simon Fraser University. He was a member of the Contract Team for the 1981 Mathematics Assessment, a co-author of the report for B.C. in the Second International Mathematics Study, and a research assistant on the Mathematics Achievement Test Project.

Garry Phillips is the Vice-Principal and a teacher at Lord Kelvin School in New Westminster. He is currently the Vice-President of the B.C.A.M.T. and a member of the Elementary Curriculum Revision Committee.

David Robitaille is Professor of Mathematics Education and Head of the Department of Mathematics and Science Education at the University of British Columbia. He has served as Chairman of the Contract Teams for all three Mathematics Assessments in British Columbia, and co-ordinated B.C. participation in the Second International Mathematics Study.

Todd Rogers is an Associate Professor in the Department of Educational Psychology and Special Education at the University of British Columbia. In 1976, he served on a Ministry of Education committee that established the Provincial Learning Assessment Program and chaired the technical sub-committee which developed the overall assessment design.

Alan Taylor was a doctoral student in Mathematics Education at the University of British Columbia at the time of the Assessment. He was on educational leave from the Ministry of Education as director of the Student Assessment Branch. He has been involved in several previous assessments and in several classroom achievement test projects.

APPENDIX B

Members of Review Panels

Primary/Grade 4

Jan Barstow	Teacher	Richmond
Pat Henry	Teacher	Alberni
Kenzie Munn	Teacher	Saanich
Flo Pachel	Teacher	Cranbrook

Intermediate/Grade 7

Ray Asai	Teacher	Peace River North
Gail Cretelli	Teacher	North Vancouver
Grant DeWolf	Teacher	Castlegar
Doreen Jeffery	Principal	Kamloops
Don Van Kleek	Teacher	Sushine Coast

Junior Secondary/Grade 10

Sharon Cairns	Teacher	Prince George
Sandra Garfinkel	Teacher	Vancouver
Tom Johnsone	Teacher	Nelson
Charles Morrison	Teacher	Campbell River
Bob Passmore	Teacher	Central Okanagan

APPENDIX C

Provincial Interpretation Panels

Grade 4

Laura Acton	Parent	Victoria
Sharron Clark	Parent	Nechako
Allan Douglas	Principal	Courtenay
Ellen Elliott	Teacher	Nanaimo Christian School
Helen Evans	Trustee	Powell River
Lionel Koh	Teacher	Armstrong
Leonard Kosiec	Teacher	Fernie
Gordon Milne	Principal	South Peace
Freda O'Sullivan	Teacher	Sooke
Marla Pickard	Teacher	Cariboo-Chilcotin
Jackie Simpson	Teacher	Surrey
Shirley Spiller	Trustee	Vernon
Sandra Verbeck	Teacher	Hope
Clive Williams	Teacher	Mission

Grade 7

Pat Aitken	Parent	Lillooet
Janet Anderson	Teacher	Prince Rupert
Steven Baker	Teacher	Terrace
Robert Belcher	Teacher	Sooke
Ian Cameron	Teacher	Armstrong
Len Fowles	Principal	Kamloops
Grace Fraser	Teacher	Burnaby
Richard Gage	Supervisor	Merritt
Peter Giltrow	Teacher	Coquitlam
Grant McDonald	Teacher	Windermere
Andrew Murray	Trustee	Abbotsford
Margaret Ormond	Trustee	Nelson
Patrick Reynolds	Teacher	Vancouver Island West
Lyn Skrlac	Parent	Port McNeill
Karen Susheski	Teacher	Surrey
Maureen Sutherland	Teacher	St. Michael's School Burnaby

Grade 10

Peter Bennett	Teacher	Penticton
H.E. Braunwarth	Teacher	Cowichan
Allan Davis	Trustee	Chilliwack
Keith Farnworth	Teacher	Grand Forks
Reg Fogarty	Teacher	Howe Sound
Barbara Glick	Teacher	Vancouver
Pat Meehan	Principal	Kitimat
Debbie Naka	Teacher	Penticton
Gry Nohr	Vice-Principal	Fort Nelson
Marion Ponzini	Parent	Delta
John Runke	Teacher	Nanaimo
Leslie Tombs	Parent	Qualicum
Keith Walker	Headmaster	Glenlyon School Victoria
John Woods	Teacher	New Westminster

APPENDIX D

Pilot Schools

Primary/Grade 4 Items (tested 57 grade 5)

School	District
Crescent Park Elementary	Surrey
Fruitvale Elementary	Trail
Happy Valley Elementary	Sooke
Malaspina Elementary	Prince George
Parksville Elementary	Qualicum
Robert L. Clemitson Elementary	Kamloops
Sooke Elementary	Sooke

Intermediate/Grade 7 Items (tested 57 grade 8)

School	District
College Heights Secondary	Prince George
Dunsmuir Secondary	Victoria
Earl Marriott Secondary	Surrey
Parksville Middle	Qualicum
Rossland Secondary	Trail
Valleyview Junior Secondary	Kamloops

Junior Secondary/Grade 10 (tested 57 grade 11)

School	District
Ballenas Secondary	Qualicum
College Heights Secondary	Prince George
Dunsmuir Secondary	Victoria
Earl Marriott Secondary	Surrey
J. Lloyd Crowe Secondary	Trail
Kamloops Secondary	Kamloops

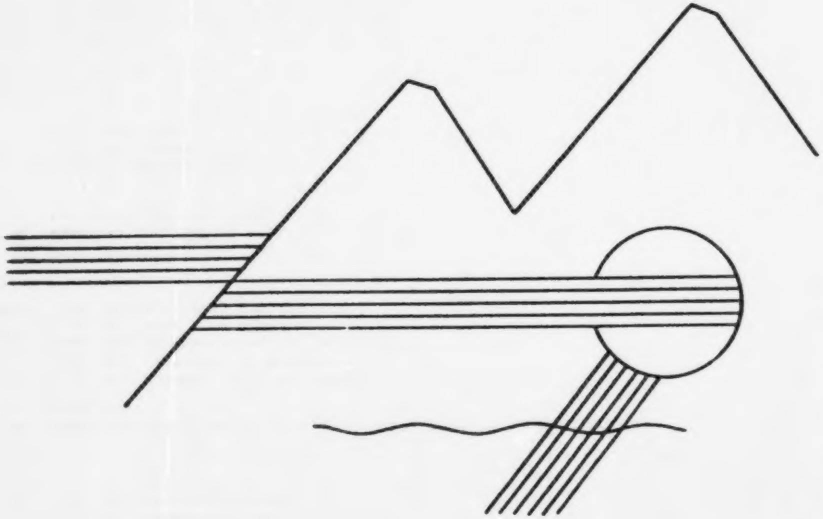
APPENDIX E

GRADE 4 DATA

BRITISH COLUMBIA
MATHEMATICS ASSESSMENT
1985

FORM R
GRADE 4

4



STUDENT BACKGROUND INFORMATION

1. What language did you first learn to speak?

78.0 A. English
1.6 B. French
9.6 C. Another language

2. What language do you speak most often in your home now?

82.5 A. English
0.7 B. French
5.7 C. Another language

3. What program are you in?

81.6 A. Regular Grade 4 Program in English
3.8 B. Early French Immersion
0.6 C. "Programme—Cadre de Français"
2.6 D. Other

4. In this class Mathematics is taught in

85.3 A. English
3.2 B. French

5. Do you sometimes go to a Learning Assistance Centre in your school for help with mathematics?

12.9 A. There is no Learning Assistance Centre for mathematics in this school.
7.6 B. Yes, I do.
68.0 C. No, I don't.

6. Do you sometimes go to an ESL class (English as a Second Language) in your school?

34.8 A. There is no ESL class in this school.
2.7 B. Yes, I do.
50.8 C. No, I don't.

7. How long did it take you to do your last mathematics homework assignment?

8.1 A. We never have mathematics homework in this class.
36.0 B. Between 1 and 10 minutes
31.6 C. Between 11 and 30 minutes
8.5 D. Between 31 and 60 minutes
3.9 E. More than an hour

8. About how much time did you spend doing homework in all subjects yesterday?

51.8 A. I didn't have any homework to do yesterday.
22.1 B. Less than 30 minutes
10.1 C. Between 30 minutes and 1 hour
2.8 D. From 1 to 2 hours
1.4 E. More than 2 hours

9. What was the highest level of school or college attended by your father or male guardian?

1.7 A. Very little or no schooling at all
5.9 B. Elementary school
8.6 C. Secondary school
18.6 D. College, university or some other form of post-secondary training.
49.1 E. I don't know.

10. What was the highest level of school or college attended by your mother or female guardian?

1.8 A. Very little or no schooling at all
4.7 B. Elementary school
10.6 C. Secondary school
20.0 D. College, university or some other form of post-secondary training.
46.9 E. I don't know.

11. Here is a list of reasons for studying mathematics. Which do you believe is most important?

14.1 A. To prepare for the next year's mathematics course
8.1 B. To learn how to perform calculations accurately
40.3 C. To learn how to use mathematics to solve problems in the real world
9.6 D. To learn to think logically
16.1 E. To learn what mathematics is

12. Which of these reasons for studying mathematics do you believe to be least important?

25.7 A. To prepare for the next year's mathematics course
13.5 B. To learn how to perform calculations accurately
9.3 C. To learn how to use mathematics to solve problems in the real world
13.3 D. To learn to think logically
25.7 E. To learn what mathematics is

Both answers given for questions 13-16 are correct. If you were asked each question, which one of the two answers comes to your mind first?

13. How much does a bicycle weigh?

40.8 A. About 15 kilograms
46.5 B. About 35 pounds

14. What is the temperature in this room?

21.4 A. About 70 degrees
65.6 B. About 20 degrees

15. How far is it from Prince George to Prince Rupert?

37.0 A. About 700 kilometres
49.8 B. About 450 miles

16. How much gasoline can the gas tank in a large car hold?

42.4 A. About 20 gallons
44.3 B. About 90 litres

SCALE B: MATHEMATICS IN SCHOOL

For each of the items in this scale, three answers are needed.

A. Tell how important you think the topic is.
B. Tell how easy it is.
C. Tell how much you like the topic.

If you are not sure what a topic means, leave its three answers blank.

1. Adding, subtracting, multiplying and dividing whole numbers

	A.		B.		C.
.9	not at all important	2.0	very difficult	4.1	dislike a lot
1.4	not important	16.0	difficult	10.3	dislike
4.7	undecided	19.1	undecided	9.2	undecided
40.0	important	48.8	easy	47.8	like
53.0	very important	14.0	very easy	28.7	like a lot

2. Learning about decimals

	A.		B.		C.
1.9	not at all important	4.9	very difficult	4.8	dislike a lot
3.6	not important	20.1	difficult	14.2	dislike
21.5	undecided	29.0	undecided	28.9	undecided
44.8	important	31.2	easy	38.4	like
28.1	very important	14.8	very easy	13.8	like a lot

3. Learning about fractions

	A.		B.		C.
1.4	not at all important	3.5	very difficult	4.1	dislike a lot
3.2	not important	16.9	difficult	10.7	dislike
8.8	undecided	16.0	undecided	12.9	undecided
48.1	important	40.5	easy	41.5	like
38.4	very important	23.2	very easy	30.8	like a lot

4. Learning the metric system

	A.		B.		C.
1.6	not at all important	5.5	very difficult	5.4	dislike a lot
3.4	not important	24.1	difficult	16.2	dislike
13.6	undecided	25.3	undecided	22.2	undecided
41.2	important	33.1	easy	40.4	like
40.1	very important	12.0	very easy	15.8	like a lot

5. Learning how to estimate

	A.		B.		C.
3.4	not at all important	4.1	very difficult	5.0	dislike a lot
8.5	not important	17.4	difficult	14.0	dislike
19.2	undecided	20.3	undecided	20.4	undecided
45.1	important	34.5	easy	37.6	like
23.8	very important	23.7	very easy	23.0	like a lot

6. Learning about squares, rectangles, and triangles

	A.		B.		C.
8.8	not at all important	1.0	very difficult	5.9	dislike a lot
20.2	not important	3.5	difficult	10.5	dislike
15.9	undecided	6.3	undecided	12.1	undecided
39.9	important	34.6	easy	40.8	like
15.2	very important	54.6	very easy	30.8	like a lot

7. Checking answers by going back over them

	A.		B.		C.
2.0	not at all important	1.8	very difficult	10.4	dislike a lot
2.9	not important	8.6	difficult	20.7	dislike
4.9	undecided	12.4	undecided	16.3	undecided
31.7	important	43.3	easy	35.3	like
58.4	very important	33.9	very easy	17.3	like a lot

8. Using graphs

	A.		B.		C.
2.7	not at all important	3.2	very difficult	4.9	dislike a lot
5.0	not important	14.4	difficult	10.3	dislike
16.5	undecided	18.1	undecided	16.4	undecided
47.3	important	38.9	easy	36.2	like
28.5	very important	25.5	very easy	32.2	like a lot

9. Solving word problems

	A.		B.		C.
3.4	not at all important	3.1	very difficult	8.0	dislike a lot
5.0	not important	17.0	difficult	16.0	dislike
15.4	undecided	16.6	undecided	12.3	undecided
47.8	important	42.5	easy	37.2	like
25.5	very important	20.8	very easy	26.4	like a lot

10. Learning about place value

	A.		B.		C.
2.3	not at all important	4.0	very difficult	6.4	dislike a lot
3.7	not important	16.2	difficult	13.8	dislike
13.2	undecided	24.5	undecided	22.3	undecided
40.6	important	35.2	easy	36.4	like
40.2	very important	20.1	very easy	21.0	like a lot

SCALE 5: GENDER AND MATHEMATICS

For each of these items choose the answer which best describes how you feel.

1. Men make better scientists and engineers than women.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
17.5	34.7	16.7	22.4	8.7

2. Girls have more natural ability in mathematics than boys.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
20.0	36.9	20.4	16.7	6.0

3. Boys need to know more mathematics than girls.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
23.1	42.2	16.4	13.5	4.8

4. A woman needs a career just as much as a man does.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3.7	8.8	11.8	47.0	28.7

5. My father enjoys doing mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
7.0	14.2	29.2	35.2	14.5

6. My mother enjoys doing mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
5.9	16.0	30.3	35.7	12.1

7. My father is usually able to help me with my mathematics homework if I ask him to help.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
4.6	8.4	8.8	46.9	31.5

8. My mother is usually able to help me with my mathematics homework if I ask her to help.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
2.7	7.0	7.9	50.0	32.3

9. My mother thinks that learning mathematics is important for me.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
1.3	1.1	3.9	32.5	61.2

10. My father thinks that learning mathematics is important for me.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
1.4	1.5	6.0	33.5	57.6

11. My father wants me to do well in mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
1.3	1.0	5.1	39.5	53.0

12. My mother wants me to do well in mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
1.6	1.5	3.7	38.3	55.0

13. Girls can do better than boys in mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
25.4	32.9	25.3	11.1	5.4

14. My mother is usually very interested in helping me with mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3.1	11.4	21.6	44.0	19.9

15. My father is usually very interested in helping me with mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3.8	10.2	22.3	41.3	24.5

SCALE T: CALCULATORS AND COMPUTERS

1. Do you own a calculator?

52.5	A.	Yes
47.5	B.	No

2. How often do you use a calculator outside school?

51.3	A.	Never
33.1	B.	Rarely (about once a week)
12.8	C.	Sometimes (a couple of times a week)
2.8	D.	Frequently (almost every day)

3. How often do you use a calculator in school?

90.7	A.	Never
5.7	B.	Rarely (about once a week)
2.8	C.	Sometimes (a couple of times a week)
0.7	D.	Frequently (almost every day)

4. Choose the one answer which best describes how your class used calculators on mathematics tests this year.

96.5	A.	Not at all; we weren't allowed to use them on tests.
1.5	B.	We were allowed to use them on some tests, if we wanted to.
0.5	C.	We were allowed to use them on all tests, if we wanted to.
1.4	D.	We were required to use them on some tests.

5. In what ways do you use a calculator to do mathematics in this class? (Mark all that apply.)

78.2	A.	Not at all; we're not allowed to use calculators in this class.
5.6	B.	To calculate answers to problems
13.3	C.	To check answers
7.9	D.	For games and fun

6. Some people say that Grade 4 students should NOT be allowed to use calculators in school. How do you feel about this?

13.2 A. Strongly Disagree
17.2 B. Disagree
15.3 C. Undecided
36.0 D. Agree
18.3 E. Strongly Agree

7. Some people say that if students are allowed to use calculators, then it should NOT be necessary for them to learn how to add, subtract, multiply, or divide by hand. How do you feel about this?

27.7 A. Strongly Disagree
23.0 B. Disagree
11.2 C. Undecided
25.0 D. Agree
13.1 E. Strongly Agree

8. Do you have a computer (one that will do more than play games) at home?

28.7 A. Yes
69.1 B. No
2.2 C. I don't know.

9. What have you used a computer to do? (Mark all that apply.)

11.0 A. Nothing, I've never used a computer.
57.4 B. To play games
15.4 C. To write stories or letters
19.0 D. To write my own programs
37.2 E. To learn about mathematics or other subjects

10. Where did you get most of your experience with computers?

21.7 A. I haven't had any experience with computers.
27.6 B. At home
50.7 C. In courses taken at school or elsewhere

FOR ITEMS 11-20, CHOOSE THE ANSWER THAT BEST DESCRIBES YOUR OPINION.

11. I would like to learn more about computers.

2.0 A. Strongly Disagree
3.1 B. Disagree
9.1 C. Undecided
44.9 D. Agree
40.9 E. Strongly Agree

12. I feel helpless around computers.

34.3 A. Strongly Disagree
38.9 B. Disagree
12.9 C. Undecided
10.1 D. Agree
3.7 E. Strongly Agree

13. Every student should be taught, in school, how to use a computer.

3.6 A. Strongly Disagree
10.4 B. Disagree
15.5 C. Undecided
43.1 D. Agree
27.3 E. Strongly Agree

14. Computers can be used to teach mathematics.

3.0 A. Strongly Disagree
4.0 B. Disagree
6.8 C. Undecided
55.8 D. Agree
30.4 E. Strongly Agree

15. Computers can be used to teach subjects other than mathematics.

2.7 A. Strongly Disagree
4.6 B. Disagree
7.4 C. Undecided
54.7 D. Agree
30.6 E. Strongly Agree

16. Using computers is more suitable for boys than for girls.

47.7 A. Strongly Disagree
27.4 B. Disagree
10.5 C. Undecided
7.5 D. Agree
6.9 E. Strongly Agree

17. I feel confident about being able to use computers.

3.4 A. Strongly Disagree
8.2 B. Disagree
19.3 C. Undecided
46.9 D. Agree
22.2 E. Strongly Agree

18. I enjoy using computers.

2.2 A. Strongly Disagree
2.5 B. Disagree
5.6 C. Undecided
40.4 D. Agree
49.3 E. Strongly Agree

19. Computers are gaining too much control over people's lives.

21.0 A. Strongly Disagree
27.7 B. Disagree
22.6 C. Undecided
18.6 D. Agree
10.2 E. Strongly Agree

20. I am able to work with computers as well as most others my age.

3.9 A. Strongly Disagree
11.5 B. Disagree
16.3 C. Undecided
45.2 D. Agree
23.1 E. Strongly Agree

Third Assessment of Mathematics

Grade 4 1985

"ORGANIZATION OF TEST ITEMS"

Objective		Test Items	Page No.
	Domain 1: Number and Operations		
1.1	Number Concepts and Computation	R: 1,2,3,27,28,29,34,35	
		S: 1,2,3,4,12,13,24,25	
		T: 1,2,3,29,30,31,47,48	
1.2	Estimation	R: 21,22,23,36	
		S: 26,29,30,31	
		T: 15,16,17,44	
1.3	Fractions and Decimals	R: 4,17,18	
		S: 35,42,43	
		T: 41,45,46	
	Domain 2: Geometry		
2.1	Geometric Figures	R: 5,37,38,39	
		S: 36,37,44,45	
		T: 4,5,42,43	
2.2	Geometric Relationships	R: 30,31,40,41	
		S: 10,11,38,39	
		T: 35,36,39,40	
	Domain 3: Measurement		
3.1	Metric Units	R: 6,9,10,42	
		S: 14,15,16,46	
		T: 6,7,8,23	
3.2	Perimeter, Area and Volume	R: 11,32,33	
		S: 17,18,22	
		T: 9,10,24	
3.3	Time and Temperature	R: 48,49	
		S: 23,47	
		T: 11,12	
	Domain 4: Algebraic Topics		
4.1	Expressions, Equations & Inequalities	R: 24,25,50	
		S: 7,8,9	
		T: 20,21,37	
4.2	Graphs	R: 7,8,19	
		S: 27,28,48	
		T: 25,27,28	

Objective			Test Items	Page No.
5.1	*	**Domain 5: Probability and Statistics** Probability	R: 15,16,20,26 S: 32,33,34,49 T: 13,14,22,38	
	*	**Domain 6: Computers and Calculators**		
6.1		Computer Literacy	R: 43,44,45 S: 19,20,21 T: 18,19,32	
6.2		Calculator Use	R: 46 S: 5 T: 33	
7.1		**Domain 7: Problem Solving**	R: 12,13,14,47 S: 6,40,41,50 T: 26,34,49,50	

* Domains 5 and 6 are not based on current curriculum.

1985 Mathematics Assessment Test Booklet Summary

Grade 4 - Form R

Item#	Objective#	Change Domain	1981 Gr.4#	1985 Gr.7#	1985 Gr.10#
1	1.1	1	C/31		
2	1.1	1	B/25		
3	1.1	1	C/25		
4	1.3				
5	2.1	2	C/39		
6	3.1	3	A/39	S/15	S/32
7	4.2				
8	4.2				
9	3.1	3	C/10		
10	3.1	3	C/30		
11	3.2	3	B/22		
12	7			T/20	R/44
13	7				
14	7				
15	5	5	C/19		
16	5				
17	1.3	1	B/34		
18	1.3				
19	4.2	4	C/36		
20	5	5	A/23		
21	1.2	1	C/20		
22	1.2				
23	1.2				
24	4.1	4	B/12		
25	4.1				
26	5	5	A/42		
27	1.1	1	B/23		
28	1.1				
29	1.1				
30	2.2				
31	2.2				
32	3.2				
33	3.2				
34	1.1	1	B/05		
35	1.1				
36	1.2	1	B/06		
37	2.1		S/05		R/21
38	2.1				
39	2.1				
40	2.2	2	C/32		
41	2.2				
42	3.1	3	C/33		T/43
43	6.1			T/33	T/35
44	6.1			R/23	R/30
45	6.1				
46	6.2				
47	7				
48	3.3	3	B/16		
49	3.3	3	C/34		
50	4.1	4	A/43		

1985 Mathematics Assessment Test Booklet Summary

Grade 4 - Form S

Item#	Objective#	Change Domain	1981 Gr.4#	1985 Gr.7#	1985 Gr.10#
1	1.1	1	B/01		
2	1.1	1	C/17		
3	1.1				
4	1.1				
5	6.2				
6	7				
7	4.1	4	A/44		
8	4.1				
9	4.1				
10	2.2	2	A/04		
11	2.2				
12	1.1	1	C/42		
13	1.1	1	C/43		
14	3.1	3	B/39	R/49	R/22
15	3.1	3	B/18		
16	3.1	3	A/17		
17	3.2	3	A/40		
18	3.2				
19	6.1			R/24	
20	6.1				
21	6.1				
22	3.2				
23	3.3	3	A/29		
24	1.1				
25	1.1				
26	1.2	1	A/24		
27	4.2	4	B/41		
28	4.2	4	B/42		
29	1.2	1	C/28		
30	1.2				
31	1.2				
32	5	5	C/45		
33	5				
34	5	5	A/22		
35	1.3	1	C/26		
36	2.1	2	B/44		
37	2.1				
38	2.2	2	A/16		
39	2.2	2	B/10		
40	7			T/50	
41	7				
42	1.3				
43	1.3				
44	2.1	2	A/33		
45	2.1				
46	3.1	3	A/30		
47	3.3				
48	4.2	4	C/41	S/44	
49	5	5	B/08		
50	7			R/18	

1985 Mathematics Assessment Test Booklet Summary

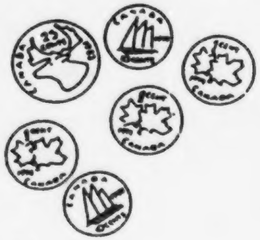
Grade 4 - Form T

Item#	Objective#	Change Domain	1981 Gr.4#	1985 Gr.7#	1985 Gr.10#
1	1.1	1	A/02		
2	1.1				
3	1.1				
4	2.1	2	C/03		
5	2.1				
6	3.1	3	C/38		
7	3.1	3	B/43		
8	3.1				
9	3.2			T/38	
10	3.2				
11	3.3	3	A/41	T/36	
12	3.3				
13	5	5	B/30		
14	5				
15	1.2	1	A/13		
16	1.2	1	B/40		
17	1.2				
18	6.1				
19	6.1				
20	4.1	4	B/20		
21	4.1	4	A/05		
22	5	5	C/44		
23	3.1	3	B/45		
24	3.2	3	C/35		
25	4.2	4	A/25		
26	7				
27	4.2				
28	4.2			R/05	
29	1.1				
30	1.1				
31	1.1	1	B/15		
32	6.1				
33	6.2				
34	7				
35	2.2	2	C/37		
36	2.2				
37	4.1				
38	5	5	C/09		
39	2.2	2	C/21		
40	2.2				
41	1.3				
42	2.1	2	B/09		
43	2.1				
44	1.2				
45	1.3				
46	1.3				
47	1.1	1	A/32		
48	1.1	1	A/31		
49	7				
50	7				

DOMAIN 1 Number & Operation

Objective 1.1 Number Concepts & Computation

1.1.1 R/1. What is the total value of the coins shown below?



3 A. 43¢
3 B. 38¢
3 C. 75¢
91 D. 48¢
1 E. I don't know.

1.1.2 R/2. Which one of the following is an odd number?

9 A. 38
72 B. 45
4 C. 42
6 D. 36
9 E. I don't know.

1.1.3. R/3. Which one of the following is the smallest number that can be made using all the digits 4, 3, 9, 1?

12 A. 1934
4 B. 1439
72 C. 1349
5 D. 1943
7 E. I don't know.

1.1.4 R/27. Which digit is in the tens place in the number in this box?

$\boxed{2079}$

4 A. 2
12 B. 0
73 C. 7
5 D. 9
3 E. I don't know.
2 Omit

1.1.5 R/28. Add:

$$\begin{array}{r} 429 \\ 35 \\ +\ \underline{531} \end{array}$$

2 A. 595
6 B. 985
84 C. 995
4 D. 9815
2 E. I don't know.
2 Omit

1.1.6 R/29. Subtract:

$$\begin{array}{r} 5806 \\ -\ \underline{2438} \end{array}$$

63 A. 3368
5 B. 3372
11 C. 3378
11 D. 3432
7 E. I don't know.
3 Omit

1.1.7 R/34. Find the missing number:

3 tens + 12 ones = □ tens + 2 ones

4 A. 2
51 B. 4
15 C. 3
10 D. 1
16 E. I don't know.
5 Omit

1.1.8 R/35. Betty, Mary and Sue want to buy their mother a present for Mother's Day. Betty has 58¢; Mary has 75¢; Sue has 89¢. How much money do they have altogether?

6 A. $2.02
9 B. $2.12
60 C. $2.22
15 D. $222
5 E. I don't know.
5 Omit

1.1.9 S/1. Which one of the following says three dollars and 26 cents?

4 A. $300.26
1 B. $ 30.26
93 C. $ 3.26
1 D. $326.00
1 E. I don't know.

1.1.10 S/2. Which one of the following numbers says four thousand two hundred sixty-five?

8 A. 42 065
1 B. 5 624
5 C. 40 265
85 D. 4 265
2 E. I don't know.

1.1.11 S/3. 300 + 40 + 5 is the same as

96 A. 345
2 B. 354
1 C. 435
1 D. 543
1 E. I don't know.

1.1.12 S/4. Which one of the following equals 5 thousands + 8 tens + 6 ones?

85 A. 5 086
2 B. 50 086
2 C. 50 806
7 D. 5 000 806
3 E. I don't know.

Sam has 51 pop bottles and 8 cartons. Each carton holds 6 bottles.

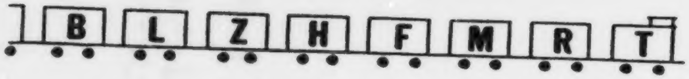
1.1.13 S/12. If Sam fills all the cartons, how many bottles will be left over?

8 A. 6
8 B. 8
54 C. 3
16 D. 14
14 E. I don't know.

1.1.14 S/13. Sam collected 38 of the bottles. His sister, Marie, collected the rest. How many bottles did Marie collect?

4 A. 18
5 B. 14
78 C. 21
4 D. 44
8 E. I don't know.

1.1.15 S/24. If Car B is the 15th car in a freight train and Car L is the 16th, which one of the following is the 20th?



3 A. Car H
71 B. Car M
9 C. Car T
8 D. Car Z
8 E. I don't know.
1 Omit

1.1.16 S/25. Which one of the following is the same as 4 x 7?

2 A. 47
5 B. 4 + 7
83 C. 7 + 7 + 7 + 7
6 D. $\frac{4}{7}$
3 E. I don't know.
1 Omit

1.1.17 T/1. The 2 in 2645 means

3 A. 2 hundreds
89 B. 2 thousands
2 C. 2 ones
4 D. 2 millions
3 E. I don't know.

1.1.18 T/2. Subtract:

$$\begin{array}{r} \$45.00 \\ -\ \underline{\$14.25} \end{array}$$

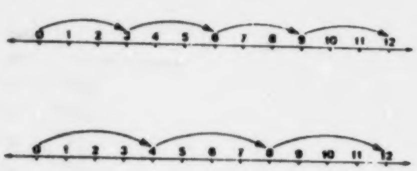
2 A. $14.70
63 B. $30.75
21 C. $31.75
5 D. $59.25
8 E. I don't know.

1.1.19 T/3. Find the product:

$$\begin{array}{r} 34 \\ \times\ \underline{7} \end{array}$$

6 A. 218
84 B. 238
2 C. 292
1 D. 301
6 E. I don't know.

1.1.20 T/29. The following diagrams show



7 A. 3 x 9 = 9 x 3
53 B. 4 x 3 = 3 x 4
9 C. 1 x 12 = 12 x 1
4 D. 6 x 2 = 2 x 6
25 E. I don't know.
2 Omit

1.1.21 T/30. 7 x 60 = 7 x (☐ x 10).

☐ equals

5 A. 4
46 B. 6
8 C. 8
13 D. 10
26 E. I don't know.
2 Omit

1.1.22 T/31. The roller coaster has 8 cars with 4 wheels on each car. How many wheels are there on the roller coaster?

9 A. 12
2 B. 2
79 C. 32
6 D. 24
2 E. I don't know.
2 Omit

Bella and Dana are killer whales.
They live in an aquarium.
Here is Bella jumping to get a fish.

1.1.23 T/47. Yesterday, Bella the whale ate a total of 98 fish in three meals. She ate 32 fish at the first meal and 25 fish at the second meal. How many fish did she eat for her third meal?

5 A. 66
58 B. 41
13 C. 155
9 D. 57
8 E. I don't know.
7 Omit

1.1.24 T/48. On Monday, 185 people saw the morning whale shows and 412 people saw the afternoon whale shows. How many people saw the whale shows that day?

76 A. 597
6 B. 697
4 C. 327
3 D. 373
4 E. I don't know.
7 Omit

Objective 1.2 Estimation

1.2.1 R/21. A hippo weighs 1153 kg, an elephant weighs 1127 kg, a moose weighs 1196 kg, and a giraffe weighs 1183 kg. Rounding to the nearest 100, which one weighs closest to 1100 kg?

5 A. hippo
76 B. elephant
11 C. moose
3 D. giraffe
3 E. I don't know.
1 Omit

1.2.2 R/22. Mrs. James spent $2.38 for fruit, $3.61 for canned goods and $1.98 for meat. About how many dollars did she spend altogether?

3 A. $5.00
16 B. $6.00
70 C. $8.00
3 D. $4.00
7 E. I don't know.
1 Omit

1.2.3 R/23. 79 + 53 is about

8 A. 120
77 B. 130
6 C. 140
4 D. 150
3 E. I don't know.
2 Omit

1.2.4 R/36. $3900 + \boxed{} = 6000$

Which one of the following is CLOSEST to the number that goes in the box?

5 A. 1000
43 B. 2000
25 C. 3000
12 D. 5000
10 E. I don't know.
5 Omit

1.2.5 S/26. Round off 43 to the nearest ten.

6 A. 30
5 B. 50
74 C. 40
10 D. 44
4 E. I don't know.
1 Omit

1.2.6 S/29. 156 rounded to the nearest 10 is

66 A. 160
20 B. 150
5 C. 170
3 D. 140
4 E. I don't know.
1 Omit

1.2.7 S/30. Abe had $3.50. He spent $1.39. About how much did he have left?

11 A. $1.50
73 B. $2.00
4 C. $3.00
1 D. $5.00
10 E. I don't know.
1 Omit

1.2.8 S/31. The answer to the subtraction exercise shown below is closest to

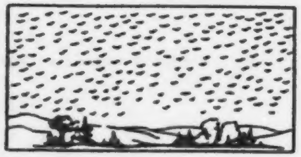
$$\begin{array}{r} 5049 \\ -\ \underline{3892} \end{array}$$

44 A. 1000
31 B. 2000
8 C. 3000
6 D. 9000
9 E. I don't know.
2 Omit

1.2.9 T/15. Round 442 to the nearest hundred.

18 A. 500
2 B. 200
1 C. 600
75 D. 400
3 E. I don't know.
1 Omit

1.2.10 T/16. This is a picture of birds flying south for the winter. About how many birds are in the picture? Do NOT try to count them.



2 A. 20
63 B. 200
20 C. 500
9 D. 1000
5 E. I don't know.
1 Omit

1.2.11 T/17. 93 - 34 is about

6 A. 40
15 B. 50
62 C. 60
7 D. 70
9 E. I don't know.
1 Omit

1.2.12 T/44. A tunnel was used by 648 cars on Monday and 304 cars on Tuesday. About how many cars used the tunnel on these days?

6 A. 300
4 B. 600
5 C. 650
70 D. 950
9 E. I don't know.
6 Omit

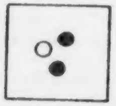
Objective 1.3 Fractions & Decimals

1.3.1. R/4. Bill bought 3 loaves of bread for $0.63 each. Find the total cost of the bread.

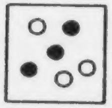
6 A. $0.21
2 B. $0.60
4 C. $0.66
84 D. $1.89
4 E. I don't know.

1.3.2 R/17. Which one of the following groups of dots is one-half ($\frac{1}{2}$) shaded?

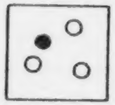
20 A.



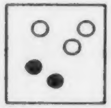
64 B.



6 C.



1 D.



7 E. I don't know.
1 Omit

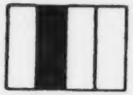
1.3.3 R/18. How many eighths are equal to $\frac{3}{4}$?

$\frac{1}{4}$		$\frac{1}{4}$		$\frac{1}{4}$		$\frac{1}{4}$	
$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$

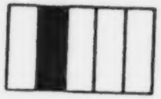
17 A. 2
14 B. 4
33 C. 6
11 D. 8
24 E. I don't know.
1 Omit

1.3.4 S/35. Which one of the following boxes is one-fifth ($\frac{1}{5}$) shaded?

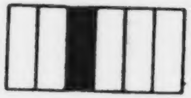
1 A.



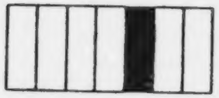
77 B.



5 C.

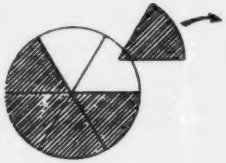


11 D.



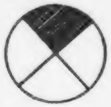
3 E. I don't know.
2 Omit

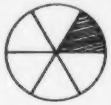
1.3.5 S/42. Which one of the following subtraction equations can be represented by the picture shown below?

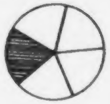


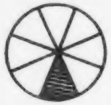
7 A. $\frac{4}{5} - \frac{1}{5} = \frac{3}{5}$
16 B. $\frac{4}{6} - \frac{1}{6} = \frac{3}{6}$
40 C. $\frac{5}{6} - \frac{1}{6} = \frac{4}{6}$
12 D. $\frac{5}{6} - \frac{2}{6} = \frac{3}{6}$
21 E. I don't know.
5 Omit

1.3.6 S/43. Which one of the following figures is one-sixth $(\frac{1}{6})$ shaded?


2 A.


82 B.


3 C.


5 D.

3 E. I don't know.
5 Omit

1.3.7 T/41. Mrs. Smith had $94.10. She bought some groceries for $24.85. How much money did she have left?

51 A. $69.25
13 B. $69.35
16 C. $70.25
7 D. $79.25
8 E. I don't know.
4 Omit

1.3.8 T/45. Add:

$$\begin{array}{r} 0.6 \\ 0.8 \\ +\ \underline{0.9} \end{array}$$

4 A. 0.023
52 B. 0.23
19 C. 2.3
16 D. 23
3 E. I don't know.

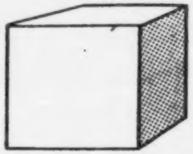
1.3.9 T/46. 6 tenths =

45 A. 6.0
22 B. 0.6
11 C. 0.06
3 D. 0.006
14 E. I don't know.
6 Omit

DOMAIN 2 Geometry

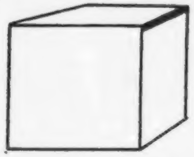
Objective 2.1 Geometric Figures

2.1.1 R/5. One face is shaded on this cube. How many faces does the cube have?



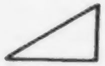
17 A. 3
76 B. 6
3 C. 8
1 D. 12
2 E. I don't know.

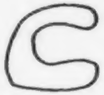
2.1.2 R/37. One edge is drawn with a thick line on this cube. How many edges does the cube have?

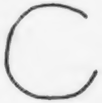


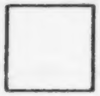
7 A. 3
9 B. 5
21 C. 9
52 D. 12
5 E. I don't know.
6 Omit

2.1.3 R/38. Which one of the following figures is OPEN?

1 A.


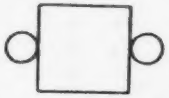
5 B.


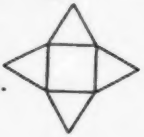
85 C.


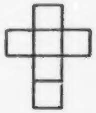
2 D.


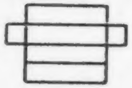
1 E. I don't know.
6 Omit

2.1.4 R/39 Which one of the following could be cut and folded to make a pyramid?

5 A.


70 B.


7 C.


5 D.


7 E. I don't know.
6 Omit

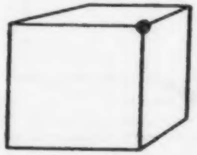
2.1.5 S/36. A soup can is shaped most like a

13 A. sphere
7 B. cube
60 C. cylinder
7 D. cone
11 E. I don't know.
2 Omit

2.1.6 S/37. If you wanted to make a triangle by driving pegs into the ground and putting string around them, how many pegs would you need?

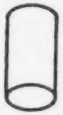
3 A. 2
72 B. 3
8 C. 4
10 D. 6
5 E. I don't know.
2 Omit

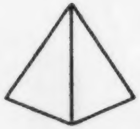
2.1.7 S/44. A dot is on one of the corners of this cube. How many corners does the cube have?

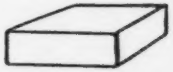


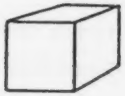
8 A. 4
7 B. 6
16 C. 7
62 D. 8
2 E. I don't know.
5 Omit

2.1.8 S/45. Which one of the following shapes has curved edges?

76 A.


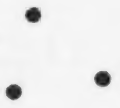
10 B.


4 C.


2 D.


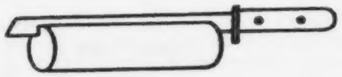
3 E. I don't know.
5 Omit

2.1.9 T/4. If you connected these three dots with straight lines, what shape would you get?

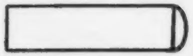


1 A. a square
5 B. a rectangle
91 C. a triangle
1 D. a circle
1 E. I don't know.

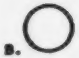
2.1.10 T/5. Lynn cut the roll of clay with a knife as shown in this picture. What will one of the pieces look like?



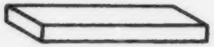
94 A.



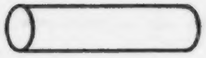
1 B.



1 C.



3 D.



1 E. I don't know.

2.1.11 T/42. The corner of this page is a square corner. How many square corners does a rectangle have?

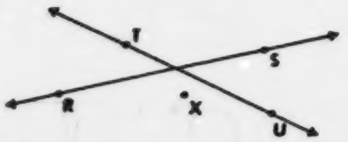
4 A. 1
12 B. 2
68 C. 4
5 D. 6
6 E. I don't know.
5 Omit

2.1.12 T/43. Which one of the following objects is most like a geometric plane?

27 A. a table top
7 B. a water glass
20 C. an ice cream cone
13 D. a shoe box
28 E. I don't know.
5 Omit

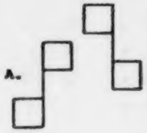
Objective 2.2 Geometric Relationships

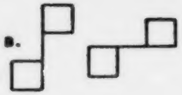
2.2.1 R/30. **Which point is closest to the intersection of the two lines shown below?**

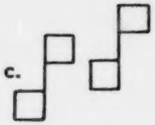


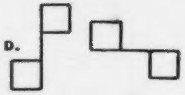
5 A. R
14 B. T
10 C. U
55 D. X
12 E. I don't know.
3 Omit

2.2.2 R/31. **In which one of the following pairs is the figure on the right a slide image of the figure on the left?**

17 A. 

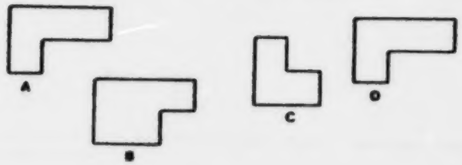
8 B. 

40 C. 

7 D. 

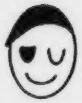
23 E. I don't know.
4 Omit

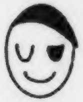
2.2.3 R/40. **Figures that are the same size and shape are congruent figures. Which of the following figures are congruent?**

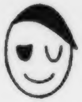


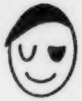
6 A. A and B
68 B. A and D
6 C. C and D
5 D. B and C
8 E. I don't know.
7 Omit

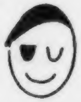
2.2.4 R/41. **If a boy with a face like the one shown on the right looked into a mirror, which one of the following faces would he see?**



40 A. 

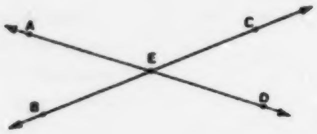
10 B. 

10 C. 

29 D. 

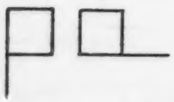
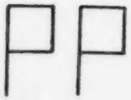
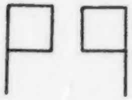
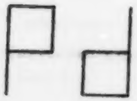
4 E. I don't know.
7 Omit

2.2.5 S/10. What point is the intersection of the two lines below?

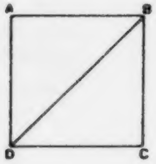


3 A. B
4 B. C
4 C. D
64 D. E
24 E. I don't know.
1 Omit

2.2.6 S/11. In which one of the following pairs is the figure on the right a flip image of the figure on the left?

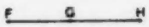
5 A.

17 B.

43 C.

16 D.

17 E. I don't know.
1 Omit

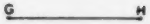
2.2.7 S/38. Which one of the following segments is NOT a side of the square?

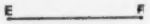


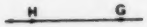
4 A. AB
5 B. BC
5 C. CD
72 D. BD
11 E. I don't know.
3 Omit

2.2.8 S/39. Which figure has G and H as its end points?

5 A.


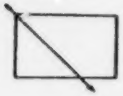
78 B.


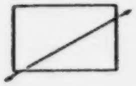
2 C.


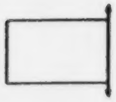
8 D.


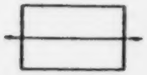
4 E. I don't know.
3 Omit

2.2.9 T/35. In which one of the following figures is the line a line of symmetry?

4 A. 

5 B. 

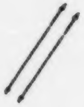
16 C. 

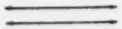
47 D. 

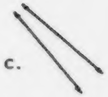
25 E. I don't know.

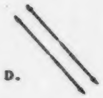
3 Omit

2.2.10 T/36. Which one of the following sets of lines is NOT parallel?

1 A. 

11 B. 

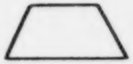
78 C. 

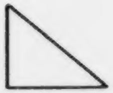
2 D. 

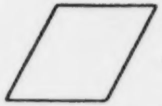
5 E. I don't know.

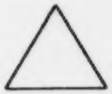
3 Omit

2.2.11 T/39. In which one of the following figures are all the angles the same size?

4 A. 

7 B. 

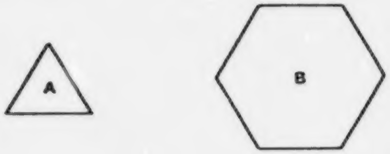
17 C. 

55 D. 

12 E. I don't know.

5 Omit

2.2.12 T/40. How many pieces the same size as A are needed to cover B?



12 A. 4

10 B. 5

56 C. 6

10 D. 7

8 E. I don't know.

4 Omit

DOMAIN 3 Measurement

Objective 3.1 Metric Units

3.1.1 R/6. A ten-year-old boy is likely to weigh

4 A. 35 grams
14 B. 75 grams
23 C. 35 kilograms
39 D. 75 kilograms
19 E. I don't know.

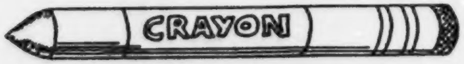
3.1.2 R/9. Which unit should be used to measure the length of a house?

8 A. millimetres
5 B. centimetres
67 C. metres
11 D. kilometres
8 E. I don't know.

3.1.3 R/10. How many centimetres are in one metre?

2 A. 1
8 B. 10
76 C. 100
10 D. 1000
5 E. I don't know.

3.1.4 R/42. About how long is this crayon?

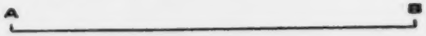


3 A. 1 centimetre
80 B. 10 centimetres
3 C. 1 metre
4 D. 10 metres
3 E. I don't know.
7 Omit

3.1.5 S/14. 5 metres is the same length as

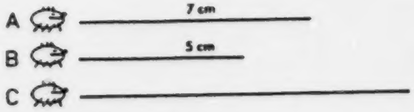
18 A. 50 centimetres
61 B. 500 centimetres
7 C. 50 millimetres
4 D. 500 millimetres
9 E. I don't know.
1 Omit

3.1.6 S/15. About how far is it from A to B?



81 A. 10 cm
6 B. 5 cm
3 C. 5 mm
6 D. 10 mm
4 E. I don't know.
1 Omit

3.1.7 S/16. Three insects travelled along the ground. Insect C travelled twice as far as insect B. How much farther did insect C travel than insect A?



18 A. 10 cm
11 B. 5 cm
7 C. 12 cm
59 D. 3 cm
5 E. I don't know.
1 Omit

Bella and Dana are killer whales.
They live in an aquarium.
Here is Bella jumping to get a fish.

3.1.8 S/46. Bella can jump 627 centimetres high. Dana can jump 5 metres high. How much higher can Bella jump than Dana?

45 A. 127 centimetres
15 B. 622 centimetres
13 C. 22 centimetres
5 D. 632 centimetres
15 E. I don't know.
6 Omit

3.1.9 T/6. A milk jug is likely to hold

4 A. 1 millilitre
4 B. 10 millilitres
80 C. 1 litre
3 D. 100 litres
8 E. I don't know.

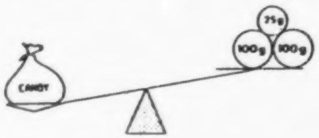
3.1.10 T/7. A paper clip would weigh about

80 A. 1 g
10 B. 10 g
1 C. 100 g
1 D. 1000 g
8 E. I don't know.
1 Omit

3.1.11 T/8. How many millilitres are in one litre?

11 A. 2
14 B. 10
26 C. 100
31 D. 1000
18 E. I don't know.
1 Omit

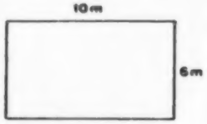
3.1.12 T/23. How much does the bag of candy weigh?



26 A. 225 g
49 B. more than 225 g
8 C. less than 225 g
8 D. 225 kg
7 E. I don't know.
1 Omit

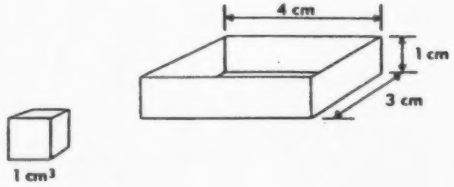
Objective 3.2 Perimeter Area & Volume

3.2.1 R/11. What is the DISTANCE ALL THE WAY AROUND this rectangle?



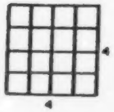
15 A. 16 m
67 B. 32 m
5 C. 36 m
9 D. 60 m
4 E. I don't know.

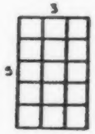
3.2.2 R/32. How many centimetre cubes are needed to fill the box?

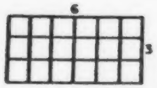


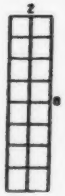
7 A. 7
18 B. 8
9 C. 10
53 D. 12
9 E. I don't know.
4 Omit

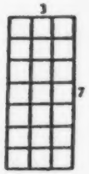
3.2.3 R/33. Which one of the following figures has the same area as the figure shown on the right?



18 A.


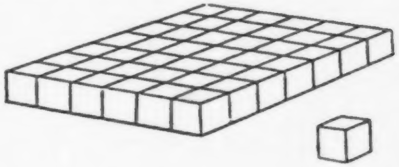
8 B.


48 C.


5 D.


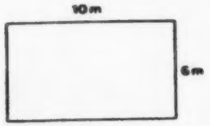
16 E. I don't know.

3.2.4 S/17. What is the volume of the figure?



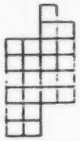
82 A. 42 cubic units
2 B. 13 cubic units
3 C. 25 cubic units
7 D. 55 cubic units
5 E. I don't know.
1 Omit

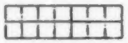
3.2.5 S/18. What is the PERIMETER of this rectangle?

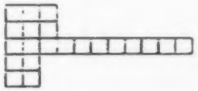


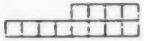
28 A. 16 m
45 B. 32 m
4 C. 36 m
13 D. 60 m
9 E. I don't know.
1 Omit

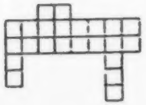
3.2.6 S/22. Which figure has the same area as the one shown on the right?



5 A.


9 B.


4 C.


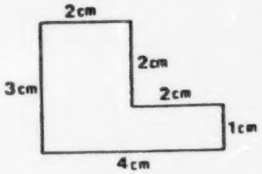
69 D.


12 E. I don't know.
1 Omit

3.2.7 T/9. Mr. Jones put a wire fence all the way around his rectangular garden. The garden is 10 m long and 6 m wide. How many metres of fencing did he use?

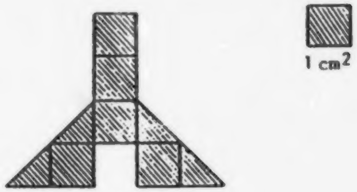
48 A. 16 m
19 B. 32 m
5 C. 36 m
22 D. 60 m
6 E. I don't know.
1 Omit

3.2.8 T/10. What is the distance around this shape?



1 A. 7 cm
1 B. 10 cm
3 C. 12 cm
92 D. 14 cm
3 E. I don't know.

3.2.9 T/24. What is the area of this shape in square centimetres?



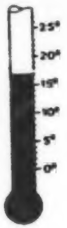
59 A. 7 cm^2
9 B. 12 cm^2
9 C. 9 cm^2
10 D. 5 cm^2
12 E. I don't know.
1 Omit

Objective 3.3 Time & Temperature

3.3.1 R/48. Teresa and Jerry played Bingo from 4:25 p.m. until 5:00 p.m. For how many minutes did they play Bingo?

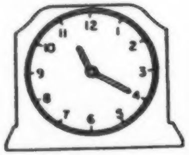
8 A. 95
9 B. 25
47 C. 35
21 D. 75
5 E. I don't know.
10 Omit

3.3.2 R/49. What temperature does this thermometer show?



1 A. 20°
75 B. 17°
2 C. 23°
10 D. 15°
1 E. I don't know.
10 Omit

3.3.3 S/23. What time does this clock show?



89 A. 11:20
2 B. 4:00
5 C. 11:40
2 D. 12:20
1 E. I don't know.
1 Omit

3.3.4 S/47. A concert started at 4:05 and ended at 4:40. How long did it last?

4 A. 20 minutes
73 B. 35 minutes
7 C. 30 minutes
5 D. 25 minutes
4 E. I don't know.
6 Omit

3.3.5 T/11. The temperature on a sunny summer day would most likely be

3 A. 5° Celsius
41 B. 25° Celsius
24 C. 55° Celsius
21 D. 85° Celsius
10 E. I don't know.

3.3.6 T/12. Which one of the following is the same as 14 days?

2 A. three weeks
1 B. one month
91 C. two weeks
2 D. one week and twelve days
2 E. I don't know.

DOMAIN 4 Algebraic Topics

Objective 4.1 Expressions, Equations & Inequalities

4.1.1 R/24. **Choose the missing number.**

$$\boxed{207 > \square > 198}$$

11 A. 188
41 B. 203
12 C. 209
11 D. 197
23 E. I don't know.
2 Omit

4.1.2 R/25. A school bus travels 48 kilometres each day. Which one of the following equations can be used to find the number of kilometres the bus will travel in 5 days?

10 A. $5 + 48 = n$
61 B. $5 \times 48 = n$
9 C. $48 + 48 + 48 + 48 = n$
5 D. $5 \times 4 \times 8 = n$
11 E. I don't know.
2 Omit

4.1.3 R/50. Bill had 148 hockey cards and his brother had 87 hockey cards. Which one of the following equations could be used to find out how many cards the two boys had together?

8 A. $148 - 87 = n$
3 B. $n + 87 = 148$
68 C. $148 + 87 = n$
3 D. $148 - n = 87$
8 E. I don't know.
11 Omit

4.1.4 S/7. **What sign is missing from the equation shown below?**

$$\boxed{6 \square 4 + 3 = 5}$$

7 A. +
80 B. −
2 C. x
4 D. ÷
7 E. I don't know.

4.1.5 S/8. Which one of the following is true?

10 A. $35 > 45$
1 B. $35 = 45$
2 C. $45 = 35$
79 D. $35 < 45$
7 E. I don't know.

4.1.6 S/9. Which two numbers would you add to check this subtraction?

$$\begin{array}{r} 476 \\ -\ \underline{337} \\ 139 \end{array}$$

22 A. 476 and 337
8 B. 476 and 139
54 C. 337 and 139
4 D. 337 and 476
10 E. I don't know.
1 Omit

4.1.7 T/20. Find the missing number.

407 < ☐

8 A. 399
68 B. 470
6 C. 407
7 D. 307
10 E. I don't know.
1 Omit

4.1.8 T/21. To find the missing number in 346 + ☐ = 931 you should

45 A. subtract 346 from 931
11 B. add 346 to 931
22 C. subtract 931 from 346
5 D. add 931 to 346
17 E. I don't know.
1 Omit

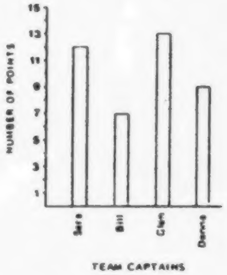
Joe collected 8 cartons of pop bottles. Each holds 6 bottles.

4.1.9 T/37. Which one of the following equations could be used to find out how many bottles Joe collected?

3 A. n + 8 = 6
4 B. 6 x n = 8
4 C. n + 6 = 8
77 D. 8 x 6 = n
8 E. I don't know.
3 Omit

Objective 4.2 Graphs

The bar graph shows the number of points scored by four hockey teams.



4.2.1 R/7. Whose team came last?

1 A. Sara's team
93 B. Bill's team
4 C. Glen's team
1 D. Donna's team
1 E. I don't know.

4.2.2 R/8. How many more points did Sara's team score than Donna's team?

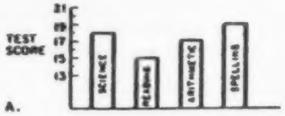
75 A. 3
14 B. 4
6 C. 12
1 D. 24
3 E. I don't know.
1 Omit

4.2.3 R/19. Leslie's test scores were:

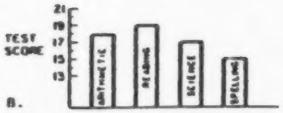
Arithmetic	18
Spelling	15
Science	17
Reading	19

Which graph shows Leslie's results?

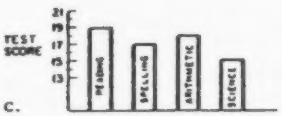
5 A.



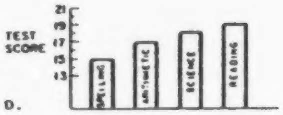
66 B.



6 C.

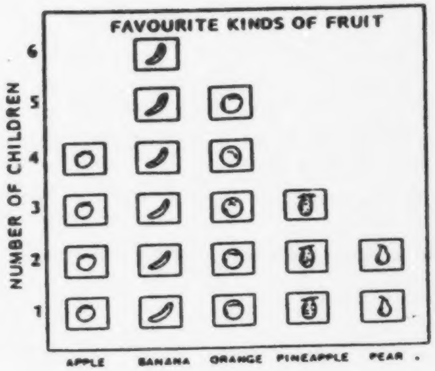


9 D.



12 E. I don't know.

1 Omit



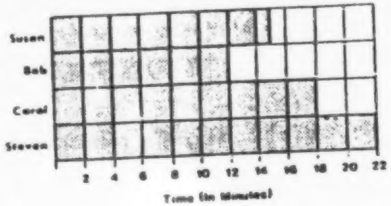
4.2.4 S/27. How many more children chose the banana than chose the pear?

81 A. 4
6 B. 2
5 C. 5
3 D. 3
3 E. I don't know.
1 Omit

4.2.5 S/28. How many children were in the group that made the graph?

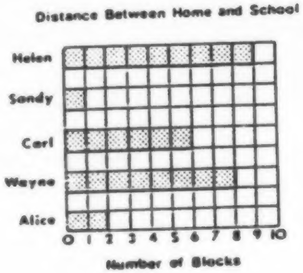
3 A. 15
66 B. 20
16 C. 5
2 D. 30
11 E. I don't know.
1 Omit

4.2.6 S/48. Pat was testing his model plane. His friends guessed how long it would stay in the air. The plane stayed up for 17 minutes. Who guessed closest to the correct time?



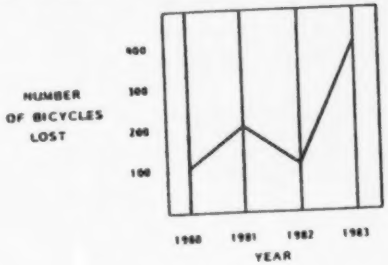
60	A.	Carol
14	B.	Susan
4	C.	Bob
11	D.	Steven
4	E.	I don't know.
7	Omit	

4.2.7 T/25. How far away from school is Wayne's house?

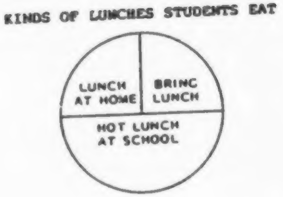


15	A.	2 blocks
2	B.	4 blocks
2	C.	6 blocks
76	D.	8 blocks
4	E.	I don't know.
1	Omit	

4.2.8 T/27. How many bicycles were lost in 1981?



8	A.	100
75	B.	200
3	C.	300
7	D.	400
5	E.	I don't know.
1	Omit	



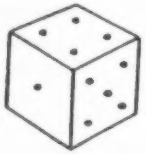
4.2.9 T/28. If 400 students eat lunch, about how many go home for lunch?

21	A.	25
39	B.	100
17	C.	200
4	D.	300
17	E.	I don't know.
2	Omit	

DOMAIN 5 Probability & Statitics

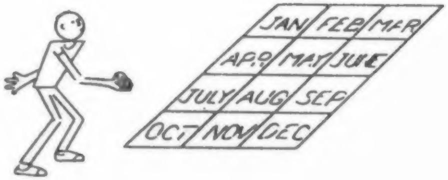
Objective 5.1 Probability & Statistics

5.1.1 R/15. If you tossed one die, what number would show up?



3 A. 1, 2, or 3
3 B. 6
7 C. an even number
80 D. any number from 1 to 6
7 E. I don't know.
1 Omit

5.1.2 R/16. You are playing a bean bag tossing game.



You win if the bean bag lands on a month that starts with the letter you choose. What letter would you choose?

38 A. J
16 B. A
24 C. M
15 D. D
7 E. I don't know.
1 Omit

5.1.3 R/20. A boy has ten socks in a drawer in a very dark room. Six socks are black and four socks are blue. What is the smallest number of socks he would have to pick to be sure of getting two of the same colour?

41 A. 2
16 B. 3
10 C. 5
18 D. 6
14 E. I don't know.
1 Omit

5.1.4 R/26. Ms. Smith and Mrs. Harris are the Grade 5 teachers. Ms. Smith's class always has arithmetic first thing in the morning.
Mrs. Harris's class sometimes has arithmetic and sometimes has reading first in the morning. If you are in Grade 5 in that school

21 A. you will have arithmetic first.
8 B. you will have reading first.
44 C. you will probably have arithmetic first.
11 D. you will probably have reading first.
14 E. I don't know.
2 Omit

5.1.5 S/32. If you toss a coin, which way is it most likely to land?

12 A. heads
7 B. tails
68 C. heads or tails
5 D. on its edge
6 E. I don't know.
2 Omit

5.1.6 S/33. Bob and Andrew found a dime. They decided to flip it once to see who would keep it.

Heads: Bob keeps it.
Tails: Andrew keeps it.

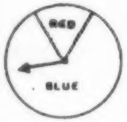
Who will win the dime?

10 A. Bob will.
6 B. Andrew will.
4 C. It will be a tie.
70 D. Either one might win.
8 E. I don't know.
2 Omit

5.1.7 S/34. The chances that lightning will strike your school are

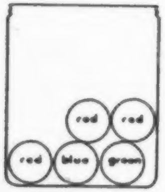
6 A. certain.
5 B. very good.
66 C. very unlikely.
13 D. impossible.
8 E. I don't know.
2 Omit

5.1.8 S/49. Sam and Sara are playing a game with this spinner. Every time the spinner lands on red, Sara gets a point. Every time the spinner lands on blue, Sam gets a point. After 10 spins, the winner will be the one with the most points. Who is more likely to win?



7 A. Sara will.
39 B. Sam will.
6 C. It will be a tie.
35 D. Either one has the same chance of winning.
6 E. I don't know.
7 Omit

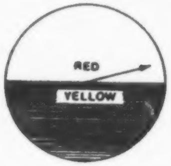
5.1.9 T/13. A jar contains 3 red marbles, 1 green one and 1 blue one. If you picked 1 marble from the jar without looking, which colour would you most likely get?



1 A. green
2 B. blue
85 C. red
9 D. You cannot tell.
2 E. I don't know.

5.1.10 T/14. $\frac{1}{2}$ of this circle is red and $\frac{1}{2}$ is yellow.

If you spin the pointer, where do you think it is most likely to land?



18 A. red
19 B. yellow
46 C. either red or yellow
6 D. on the line
10 E. I don't know.
1 Omit

5.1.11 T/22. The chances that it will snow in Victoria in July are

4 A. certain.
6 B. very good.
46 C. very unlikely.
34 D. impossible.
10 E. I don't know.
1 Omit

5.1.12 T/38. A jar contained 2 blue pens, 4 red ones and 1 black one. Brad could not decide whether he wanted a red pen or a blue pen. He closed his eyes and picked one from the jar. Which colour did he most likely pick?

8 A. blue or black
65 B. red
10 C. blue
6 D. black
9 E. I don't know.
4 Omit

DOMAIN 6 Computers & Calculators

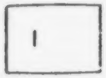
Objective 6.1 Computer Literacy

6.1.1 R/43. A list of instructions for a computer is called a

50 A. program.
20 B. disk.
8 C. terminal.
8 D. memory.
6 E. I don't know.
8 Omit

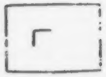
6.1.2 R/44. An imaginary computer can draw pictures on a television screen. When given the instruction MOVE

it will draw a picture like this:



When given the instruction MOVE R MOVE

it will draw this picture:



Which one of the following sets of instructions would draw a square?

7 A. R R R R
10 B. MOVE R R R
9 C. MOVE MOVE MOVE MOVE
50 D. MOVE R MOVE R MOVE R MOVE
16 E. I don't know.
8 Omit

6.1.3 R/45. For which one of the following would people NOT use a computer?

7 A. to find the sum of a column of numbers
7 B. to keep track of school records
61 C. to decide the winner of a dog show
7 D. to put a list of names in alphabetical order
8 E. I don't know.
9 Omit

6.1.4 S/19. An imaginary computer will input two numbers and print their sum if these instructions are given to it:

```
TELL A
TELL B
WRITE A + B
```

What would the same computer print if given these instructions?

```
TELL A
TELL B
WRITE A * B
```

25 A. the sum of the numbers
18 B. the product of the numbers
12 C. the quotient of the numbers
10 D. the difference of the numbers
33 E. I don't know.
2 Omit

6.1.5 S/20. Computers are used

3 A. only by very smart people.
2 B. only by scientists.
88 C. by many different kinds of people.
4 D. only by big institutions like businesses and universities.
3 E. I don't know.
1 Omit

6.1.6 S/21. Computers are NOT good for tasks that require

21 A. speed.
11 B. accuracy.
36 C. judgment.
17 D. something to be done over and over again.
14 E. I don't know.
1 Omit

6.1.7 T/18. An imaginary computer will print the word HOT DOG if given these instructions:

```
FIRST="HOT"
SECOND="DOG"
TYPE FIRST & SECOND
```

What will the same computer print if given these instructions?

```
FIRST="HOT"
SECOND="DOG"
TYPE SECOND & FIRST
```

45 A. DOG HOT
3 B. HOT
2 C. DOG
40 D. HOT DOG
8 E. I don't know.
1 Omit

6.1.8 T/19. A set of instructions for an imaginary computer is as follows:

1. Arrange the three names Sandy, Dale and Pat in alphabetical order.
2. Remove the last name from the list.
3. Print the list.

What will the computer print?

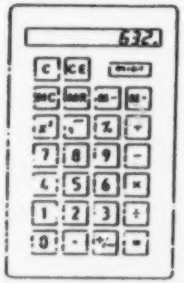
3 A. Pat
46 B. Dale, Pat
38 C. Dale, Pat, Sandy
4 D. Pat, Dale
9 E. I don't know.
1 Omit

6.1.9 T/32. A computer diskette works most like a

61 A. cassette tape.
21 B. TV screen.
3 C. walkie-talkie.
3 D. radio.
10 E. I don't know.
2 Omit

Objective 6.2 Calculator Use

6.2.1 R/46. The three digits in the display have just been entered. Now the $\boxed{7}$ key is pressed. What number will appear in the display?



10 A. $\boxed{637.}$

11 B. $\boxed{639.}$

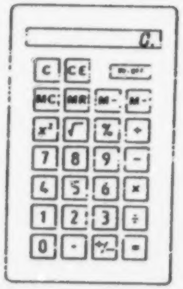
46 C. $\boxed{6327.}$

11 D. $\boxed{7632.}$

13 E. I don't know.

9 Omit

6.2.2 S/5. To divide 27 by 3 on the calculator, you would press



21 A. $\boxed{3}\boxed{\div}\boxed{2}\boxed{7}\boxed{=}$

1 B. $\boxed{3}\boxed{\sqrt{}}\boxed{2}\boxed{7}\boxed{=}$

2 C. $\boxed{2}\boxed{7}\boxed{+/-}\boxed{3}\boxed{=}$

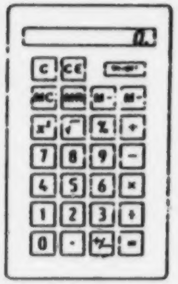
72 D. $\boxed{2}\boxed{7}\boxed{\div}\boxed{3}\boxed{=}$

3 E. I don't know.

6.2.3 T/33. These keys have been pressed on the calculator:

$\boxed{6}\boxed{+}\boxed{1}\boxed{=}$

What will the calculator display show?



7 A. $\boxed{6.}$

72 B. $\boxed{7.}$

2 C. $\boxed{61.}$

13 D. $\boxed{6+1.}$

3 E. I don't know.

2 Omit

DOMAIN 7 Problem Solving

Objective 7.1 Problem Solving

7.1.1 R/12. I am a number between 25 and 40. I have a remainder of 2 when divided by both 6 and by 9. Who am I?

9 A. 26
9 B. 29
22 C. 32
27 D. 38
32 E. I don't know.
1 Omit

7.1.2 R/13. In a class there are more than 10 boys and more than 8 girls. What do you know about the number of children in the class?

61 A. There are more than 18.
8 B. There are fewer than 18.
24 C. There are more than 20.
2 D. There are fewer than 2.
4 E. I don't know.
1 Omit

7.1.3 R/14. Joel had $3.50. He bought 6 apples for 25¢ each. How much money did Joel have left after buying the apples?

To solve the problem given above, which one of the following pairs of operations must you use?

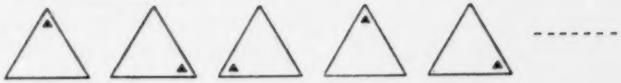
44 A. multiplication and subtraction
14 B. addition and division
10 C. multiplication and division
19 D. division and subtraction
12 E. I don't know.
1 Omit

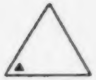
7.1.4 R/47. Which one of the following numbers comes next?

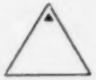
2080, 2060, 2040, 2020, 2000, 1980, ...

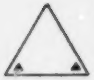
7 A. 1890
7 B. 1900
60 C. 1960
8 D. 2080
8 E. I don't know.
10 Omit

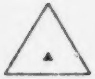
7.1.5 S/6. Which figure comes next?



61 A. 

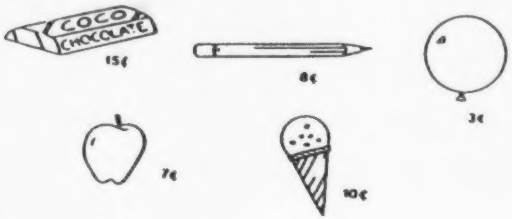
6 B. 

7 C. 

9 D. 

16 E. I don't know.
1 Omit

7.1.6 S/40. **Joyce has 50¢. Which of the following can she buy?**

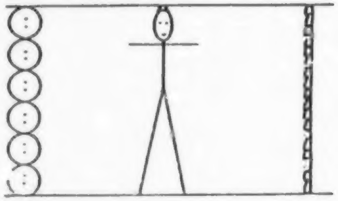


13	A.	3 apples and 3 ice cream cones
39	B.	5 apples and 3 balloons
11	C.	4 ice cream cones and a chocolate bar
13	D.	3 chocolate bars and a pencil
21	E.	I don't know.
4	Omit	

7.1.7 S/41. Mrs. Wildish bought some flower bulbs to plant. One half of them were tulip bulbs. What else do you need to know to find out how many were tulip bulbs?

9	A.	how big tulip bulbs are
7	B.	what other kinds of flowers Mrs. Wildish likes
47	C.	how many flower bulbs Mrs. Wildish bought
17	D.	what other types of bulbs Mrs. Wildish bought
15	E.	I don't know.
4	Omit	

7.1.8 S/50. **The stickman below is Mr. Big. He is 9 paper clips tall or 6 buttons tall. There is another stickperson, Mr. Short, who is 6 paper clips tall. How many buttons tall would he be?**



5	A.	$1\frac{1}{2}$
32	B.	3
35	C.	4
12	D.	5
10	E.	I don't know.
7	Omit	

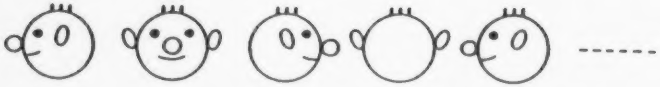
7.1.9 T/26. Jerry has a total of 24 golf balls and tennis balls. If he has 4 more tennis balls than golf balls, how many of each does Jerry have?

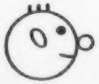
13	A.	8 golf balls and 16 tennis balls
10	B.	12 tennis balls and 12 golf balls
18	C.	20 golf balls and 4 tennis balls
34	D.	14 tennis balls and 10 golf balls
23	E.	I don't know.
1	Omit	

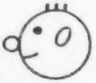
7.1.10 T/34. Jason bought 3 boxes of pencils. What else do you need to know in order to find how many pencils he bought?

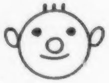
11	A.	how much each box cost
5	B.	how much money Jason had
71	C.	how many pencils were in each box
3	D.	how much change Jason received
6	E.	I don't know.
3	Omit	

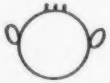
7.1.11 T/49. Which figure comes next?



8 A. 

7 B. 

59 C. 

6 D. 

12 E. I don't know.

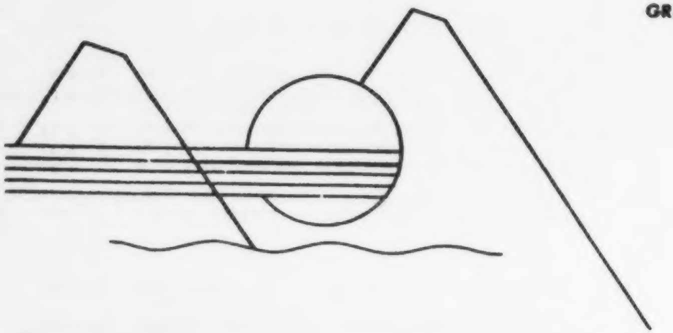
7 Omit

7.1.12 T/50. It was 4:00 in the afternoon. Ken played tennis for 40 minutes. Then he rode his bike for an hour and a half. How many minutes longer did Ken ride his bike than play tennis?

Mark the information you DO NOT need to know in order to solve the problem.

27 A. It was 4:00 in the afternoon.
23 B. One hour is 60 minutes.
13 C. He rode his bike for an hour and a half.
7 D. Ken played tennis for 40 minutes.
21 E. I don't know.
10 Omit

GRADE 7 7



BRITISH COLUMBIA
MATHEMATICS ASSESSMENT 1985

STUDENT BACKGROUND INFORMATION

1. What language did you first learn to speak?
   - 80.2 A. English
   - 1.3 B. French
   - 8.8 C. Another language

2. What language do you speak most often in your home now?
   - 85.3 A. English
   - 0.7 B. French
   - 4.3 C. Another language

3. What program are you in?
   - 81.8 A. Regular Program in English
   - 4.3 B. Early French Immersion
   - 1.9 C. Late French Immersion
   - 1.1 D. "Programme-Cadre de Français"

4. In this class Mathematics is taught in
   - 87.9 A. English
   - 2.0 B. French

5. Do you sometimes go to a Learning Assistance Centre in your school for help with mathematics?
   - 8.7 A. There is no Learning Assistance Centre for mathematics in this school.
   - 4.4 B. Yes, I do.
   - 76.8 C. No, I don't.

6. Do you sometimes go to an ESL class (English as a Second Language) in your school?
   - 36.1 A. There is no ESL class in this school.
   - 2.0 B. Yes, I do.
   - 51.7 C. No, I don't.

7. How long did it take you to do your last mathematics homework assignment?

3.6 A. We never have mathematics homework in this class.
25.9 B. Between 1 and 10 minutes
46.6 C. Between 11 and 30 minutes
10.9 D. Between 31 and 60 minutes
3.0 E. More than an hour

8. About how much time did you spend doing homework in all subjects yesterday?

34.5 A. I didn't have any homework to do yesterday.
19.9 B. Less than 30 minutes
22.0 C. Between 30 minutes and 1 hour
10.1 D. From 1 to 2 hours
3.5 E. More than 2 hours

9. What was the highest level of school or college attended by your father or male guardian?

1.3 A. Very little or no schooling at all
3.1 B. Elementary school
20.3 C. Secondary school
25.6 D. College, university or some other form of post-secondary training
34.2 E. I don't know.

10. What was the highest level of school or college attended by your mother or female guardian?

1.0 A. Very little or no schooling at all
2.2 B. Elementary school
24.9 C. Secondary school
26.4 D. College, university or some other form of post-secondary training
30.0 E. I don't know.

11. Here is a list of reasons for studying mathematics. Which do you believe is most important?

10.4 A. To prepare for the next year's mathematics course
11.8 B. To learn how to perform calculations accurately
51.9 C. To learn how to use mathematics to solve problems in the real world
8.7 D. To learn to think logically
6.8 E. To learn what mathematics is

12. Which of these reasons for studying mathematics do you believe to be least important?

23.2 A. To prepare for the next year's mathematics course
8.0 B. To learn how to perform calculations accurately
4.7 C. To learn how to use mathematics to solve problems in the real world
17.2 D. To learn to think logically
36.2 E. To learn what mathematics is

Both answers given for questions 13-16 are correct. If you were asked each question, which one of the two answers comes to mind first?

13. How much does a bicycle weigh?

33.5 A. About 15 kilograms
55.9 B. About 35 pounds

14. What is the temperature in this room?

35.1 A. About 70 degrees
53.9 B. About 20 degrees

15. How far is it from Prince George to Prince Rupert?

36.3 A. About 700 kilometres
52.8 B. About 450 miles

16. How much gasoline can the gas tank in a large car hold?

45.9 A. About 20 gallons
43.0 B. About 90 litres

SCALE B: MATHEMATICS IN SCHOOL

For each of the items in this scale, three answers are needed.

A. Tell how important you think the topic is.
B. Tell how how easy it is.
C. Tell how much you like the topic.

If you are not sure what a topic means, leave its three answers blank.

1. Adding, subtracting, multiplying and dividing fractions

	A.		B.		C.
0.9	not at all important	1.0	very difficult	4.4	dislike a lot
4.0	not important	14.5	difficult	19.1	dislike
7.6	undecided	18.7	undecided	19.0	undecided
57.9	important	52.9	easy	49.5	like
29.5	very important	12.8	very easy	8.0	like a lot

2. Adding, subtracting, multiplying and dividing decimals

	A.		B.		C.
0.7	not at all important	1.5	very difficult	3.4	dislike a lot
2.7	not important	13.7	difficult	16.7	dislike
8.7	undecided	14.9	undecided	17.7	undecided
54.6	important	50.3	easy	50.1	like
33.2	very important	19.5	very easy	12.5	like a lot

3. Working with percents

	A.		B.		C.
0.9	not at all important	2.8	very difficult	4.4	dislike a lot
3.2	not important	19.4	difficult	17.0	dislike
9.6	undecided	22.0	undecided	20.8	undecided
47.6	important	40.4	easy	42.7	like
38.7	very important	15.3	very easy	15.2	like a lot

4. Learning about estimation

	A.		B.		C.
3.3	not at all important	1.9	very difficult	5.3	dislike a lot
17.3	not important	12.6	difficult	22.3	dislike
26.3	undecided	21.5	undecided	29.0	undecided
42.2	important	39.7	easy	35.1	like
11.0	very important	24.2	very easy	8.2	like a lot

5. Memorizing basic facts

	A.		B.		C.
1.8	not at all important	2.6	very difficult	6.0	dislike a lot
4.6	not important	16.9	difficult	22.7	dislike
10.8	undecided	24.2	undecided	30.2	undecided
41.2	important	40.2	easy	33.8	like
41.6	very important	16.1	very easy	7.3	like a lot

6. Solving equations

	A.		B.		C.
1.2	not at all important	1.2	very difficult	4.2	dislike a lot
4.8	not important	9.8	difficult	15.3	dislike
10.4	undecided	22.0	undecided	22.0	undecided
51.4	important	49.9	easy	45.8	like
32.3	very important	17.1	very easy	12.7	like a lot

7. Solving word problems

	A.		B.		C.
4.7	not at all important	4.9	very difficult	15.2	dislike a lot
14.4	not important	24.7	difficult	29.1	dislike
20.8	undecided	27.3	undecided	18.5	undecided
44.5	important	35.2	easy	28.2	like
15.5	very important	7.9	very easy	9.0	like a lot

8. Learning about the metric system

	A.		B.		C.
2.4	not at all important	7.3	very difficult	12.5	dislike a lot
3.4	not important	27.5	difficult	22.7	dislike
7.8	undecided	24.3	undecided	23.3	undecided
33.0	important	29.4	easy	31.0	like
53.4	very important	11.5	very easy	10.5	like a lot

9. Working with perimeter and area

	A.		B.		C.
2.4	not at all important	4.4	very difficult	8.9	dislike a lot
7.3	not important	20.3	difficult	21.1	dislike
18.8	undecided	24.8	undecided	24.1	undecided
50.6	important	38.2	easy	35.7	like
21.0	very important	12.4	very easy	10.1	like a lot

10. Doing geometry

	A.		B.		C.
3.4	not at all important	4.5	very difficult	9.5	dislike a lot
8.0	not important	18.3	difficult	16.9	dislike
19.9	undecided	26.6	undecided	21.1	undecided
46.4	important	36.5	easy	31.6	like
22.3	very important	14.0	very easy	20.8	like a lot

SCALE 5: GENDER AND MATHEMATICS

For each of these items choose the answer which best describes how you feel.

1. Men make better scientists and engineers than women.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
28.5	42.6	15.4	11.2	2.3

2. Girls have more natural ability in mathematics than boys.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
19.3	46.3	22.2	10.7	1.5

3. Boys need to know more mathematics than girls.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
25.6	49.3	14.3	8.9	1.9

4. A woman needs a career just as much as a man does.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
1.6	5.0	6.8	44.8	41.9

5. My father enjoys doing mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
6.1	15.0	38.4	30.3	10.3

6. My mother enjoys doing mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
6.7	21.5	38.2	27.8	5.9

7. My father is usually able to help me with my mathematics homework if I ask him to help.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
5.0	10.6	11.2	45.8	27.3

8. My mother is usually able to help me with my mathematics homework if I ask her to help.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3.4	13.5	12.7	49.3	21.1

9. My mother thinks that learning mathematics is important for me.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
0.4	0.6	5.4	38.2	55.4

10. My father thinks that learning mathematics is important for me.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
0.7	0.9	8.5	35.0	54.9

11. My father wants me to do well in mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
0.5	0.6	7.5	41.0	50.5

12. My mother wants me to do well in mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
0.5	0.7	4.4	41.5	52.8

13. Girls can do better than boys in mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
25.1	38.7	24.9	8.9	2.4

14. My mother is usually very interested in helping me with mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3.3	18.2	29.6	37.8	11.1

15. My father is usually very interested in helping me with mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
4.1	12.8	28.7	38.0	16.4

SCALE T: CALCULATORS AND COMPUTERS

1. Do you own a calculator?

70.7	A.	Yes
29.3	B.	No

2. How often do you use a calculator outside school?

32.1	A.	Never
46.8	B.	Rarely (about once a week)
19.0	C.	Sometimes (a couple of times a week)
2.1	D.	Frequently (almost every day)

3. How often do you use a calculator in school?

72.3	A.	Never
16.9	B.	Rarely (about once a week)
8.1	C.	Sometimes (a couple of times a week)
2.7	D.	Frequently (almost every day)

4. Choose the one answer which best describes how your class used calculators on mathematics tests this year.

91.8	A.	Not at all; we weren't allowed to use them on tests.
6.2	B.	We were allowed to use them on some tests, if we wanted to.
0.3	C.	We were allowed to use them all tests, if we wanted to.
1.7	D.	We were required to use them on some tests.

5. In what ways do you use a calculator to do mathematics in this class? (Mark all that apply.)

56.9	A.	Not at all; we're not allowed to use calculators in this class.
18.6	B.	To calculate answer to problems
30.6	C.	To check answers
8.2	D.	For games and fun

6. Some people say that Grade 7 students should NOT be allowed to use calculators in school. How do you feel about this?

10.2 A. Strongly Disagree
28.7 B. Disagree
28.1 C. Undecided
25.7 D. Agree
7.4 E. Strongly Agree

7. Some people say that if students are allowed to use calculators, then it should NOT be necessary for them to learn how to add, subtract, multiply, or divide by hand. How do you feel about this?

41.3 A. Strongly Disagree
28.1 B. Disagree
10.6 C. Undecided
14.5 D. Agree
5.6 E. Strongly Agree

8. Do you have a computer (one that will do more than play games) at home?

32.0 A. Yes
66.8 B. No
1.2 C. I don't know.

9. What have you used a computer to do? (Mark all that apply.)

6.6 A. Nothing, I've never used a computer.
67.4 B. To play games
28.5 C. To write stories or letters
40.8 D. To write my own programs
34.3 E. To learn about mathematics or other subjects

10. Where did you get most of your experience with computers?

12.7 A. I haven't had any experience with computers.
23.7 B. At home
63.6 C. In courses taken at school or elsewhere

FOR ITEMS 11-20, CHOOSE THE ANSWER THAT BEST DESCRIBES YOUR OPINION.

11. I would like to learn more about computers.

1.4 A. Strongly Disagree
3.2 B. Disagree
11.8 C. Undecided
43.1 D. Agree
40.6 E. Strongly Agree

12. I feel helpless around computers.

24.8 A. Strongly Disagree
45.5 B. Disagree
16.9 C. Undecided
10.1 D. Agree
2.7 E. Strongly Agree

13. Every student should be taught, in school, how to use a computer.

2.5 A. Strongly Disagree
8.0 B. Disagree
15.5 C. Undecided
43.2 D. Agree
30.8 E. Strongly Agree

14. Computers can be used to teach mathematics.

2.4 A. Strongly Disagree
5.4 B. Disagree
10.0 C. Undecided
56.3 D. Agree
25.9 E. Strongly Agree

15. Computers can be used to teach subjects other than mathematics.

1.9 A. Strongly Disagree
3.9 B. Disagree
10.3 C. Undecided
56.3 D. Agree
27.7 E. Strongly Agree

16. Using computers is more suitable for boys than for girls.

61.8 A. Strongly Disagree
24.9 B. Disagree
7.4 C. Undecided
2.8 D. Agree
3.1 E. Strongly Agree

17. I feel confident about being able to use computers.

2.4 A. Strongly Disagree
8.4 B. Disagree
25.8 C. Undecided
47.6 D. Agree
15.8 E. Strongly Agree

18. I enjoy using computers.

1.8 A. Strongly Disagree
3.1 B. Disagree
8.7 C. Undecided
46.2 D. Agree
40.3 E. Strongly Agree

19. Computers are gaining too much control over people's lives.

12.0 A. Strongly Disagree
25.0 B. Disagree
29.7 C. Undecided
21.8 D. Agree
11.5 E. Strongly Agree

20. I am able to work with computers as well as most others my age.

3.5 A. Strongly Disagree
17.7 B. Disagree
22.6 C. Undecided
42.6 D. Agree
13.6 E. Strongly Agree

Third Assessment of Mathematics

Grade 7 1985

"ORGANIZATION OF TEST ITEMS"

Objective		Test Items	Page No.
	Domain 1: Number and Operations		
1.1	Number Concepts	R: 1,2,3,4,40	
		S: 1,2,3,4,25	
		T: 1,2,3,4,47	
1.2	Fractions and Decimals	R: 14,15,16,41,42,43	
		S: 11,12,13,26,27,48	
		T: 9,15,16,17,48,49	
1.3	Ratio, Proportion and Percentages	R: 8,9,37	
		S: 19,49,50	
		T: 10,11,39	
	Domain 2: Geometry		
2.1	Geometric Figures	R: 12,13,19,20,38,39	
		S: 5,6,9,10,20,21	
		T: 12,13,27,40,41,42	
2.2	Geometric Relationships	R: 26,27,31,32,44,45	
		S: 36,37,39,40,41,42	
		T: 14,18,19,28,29,43	
	Domain 3: Measurement		
3.1	Metric Units	R: 21,48,49	
		S: 14,15,38	
		T: 35,36,37	
3.2	Perimeter, Area and Volume	R: 28,50	
		S: 16,22	
		T: 38,44	
	Domain 4: Algebraic Topics		
4.1	Expressions, Equations and Inequalities	R: 29,30,33,34,35,36	
		S: 23,24,30,31,32,33	
		T: 5,24,25,26,45,46	
4.2	Graphs	R: 5,46	
		S: 43,44	
		T: 6,23	

Objective		Test Items	Page No.
	* Domain 5: Probability & Statistics		
5.1	Probability	R: 6,47 S: 17,18 T: 30,31	
5.2	Statistics	R: 7,10 S: 45,46 T: 7,32	
	* Domain 6: Computers and Calculators		
6.1	Computer Literacy	R: 23,24 S: 7,8 T: 33,34	
6.2	Calculator Use	R: 11,22 S: 28,29 T: 21,22	
7.1	Domain 7: Problem Solving	R: 17,18,25 S: 34,35,47 T: 8,20,50	

* Domains 5 and 6 are not based on current curriculum.

1985 Mathematics Assessment Test Booklet Summary

Grade 7 - Form R

Item#	Objective#	Change Domain	1981 Gr.4#	1985 Gr.7#	1985 Gr.10#
1	1.1				
2	1.1				
3	1.1				
4	1.1	1	B/40		
5	4.2	4	C/14	T/28	
6	5.1	5	C/22		T/25
7	5.2	5	C/15		
8	1.3				
9	1.3				
10	5.2	5	C/05		
11	6.2				R/13
12	2.1				
13	2.1				
14	1.2				
15	1.2	1	A/12		
16	1.2	1	A/30		R/26
17	7				T/12
18	7			S/50	
19	2.1				
20	2.1	2	A/21		T/20
21	3.1	3	A/17		
22	6.2				T/46
23	6.1			R/44	R/30
24	6.1			S/19	
25	7				T/49
26	2.2				
27	2.2				
28	3.2	3	A/40		
29	4.1				
30	4.1				
31	2.2				
32	2.2				
33	4.1				
34	4.1	4	A/02		
35	4.1	4	B/35		
36	4.1	4	B/29		
37	1.3	1	C/13		T/26
38	2.1				
39	2.1				
40	1.1	1	A/03		
41	1.2				
42	1.2				
43	1.2				
44	2.2	2	B/07		
45	2.2	2	C/28		
46	4.2				
47	5.1				
48	3.1				
49	3.1	3	B/15	S/14	R/22
50	3.2				

1985 Mathematics Assessment Test Booklet Summary

Grade 7 - Form S

Item#	Objective#	Change Domain	1981 Gr.4#	1985 Gr.7#	1985 Gr.10#
1	1.1				
2	1.1				
3	1.1				
4	1.1	1	A/36		
5	2.1	2	A/04	R/37	R/21
6	2.1	2	B/28		S/48
7	6.1				S/12
8	6.1				R/31
9	2.1				
10	2.1				
11	1.2				
12	1.2				
13	1.2	1	B/23		
14	3.1	3	C/33		
15	3.1	3	C/17	R/06	S/32
16	3.2				
17	5.1	5	A/45		S/11
18	5.1	5	B/11		
19	1.3				
20	2.1				
21	2.1				
22	3.2	3	C/38		
23	4.1				
24	4.1				
25	1.1	1	B/06		
26	1.2				
27	1.2				
28	6.2				T/33
29	6.2				S/23
30	4.1				
31	4.1				
32	4.1	4	A/13		
33	4.1	4	B/21		
34	7				S/50
35	7				R/43
36	2.2				
37	2.2				
38	3.1				
39	2.2	2	B/42		
40	2.2				
41	2.2				
42	2.2	2	C/10		
43	4.2				
44	4.2	4	A/39	S/48	
45	5.2	5	A/46		
46	5.2	5	B/05		
47	7				
48	1.2	1	B/17		R/01
49	1.3				
50	1.3	1	A/23		

1985 Mathematics Assessment Test Booklet Summary

Grade 7 - Form T

Item#	Objective#	Change Domain	1981 Gr.4#	1985 Gr.7#	1985 Gr.10#
1	1.1				
2	1.1				
3	1.1				
4	1.1	1	C/23		
5	4.1	4	A/44		
6	4.2	4	C/31		
7	5.2				
8	7				
9	1.2	1	C/02		
10	1.3				
11	1.3				
12	2.1				
13	2.1	2	C/30		
14	2.2				
15	1.2				
16	1.2				
17	1.2	1	C/20		
18	2.2				
19	2.2				
20	7			R/12	R/44
21	6.2				S/43
22	6.2				S/22
23	4.2				
24	4.1				
25	4.1				
26	4.1	4	C/06		
27	2.1	2	C/42		
28	2.2				
29	2.2	1	A/28		
30	5.1	5	A/24		
31	5.1	5	C/16		S/07
32	5.2	5	A/33		
33	6.1			R/43	T/35
34	6.1				S/44
35	3.1				
36	3.1	3	A/15	T/11	
37	3.1	3	A/25		
38	3.2	3	A/16	T/09	
39	1.3	1	B/30		
40	2.1				
41	2.1				
42	2.1				
43	2.2				
44	3.2	2	B/18		T/22
45	4.1				
46	4.1				
47	1.1	1	C/25		
48	1.2				
49	1.1				
50	7			S/40	

DOMAIN 1 Number & Operations

Objective 1.1 Number Concepts

1.1.1 R/1. The statement "thirty is less than forty-five" is shown by

12 A. $30 > 45$
84 B. $30 < 45$
2 C. $45 < 30$
0 D. $45 \leq 30$
1 E. I don't know.

1.1.2 R/2. Which is the correct name for the missing number?

$$3 \times 26 = (3 \times \square) + (3 \times 6)$$

14 A. 2
10 B. 6
57 C. 20
7 D. 26
12 E. I don't know.
1 Omit

1.1.3 R/3. Joe packs tomatoes 4 to a box. If he has packed 18 tomatoes, which box is he now packing?

15 A. the fourth
73 B. the fifth
6 C. the sixth
3 D. the eighteenth
4 E. I don't know.

1.1.4 R/4. Multiply:

$$\begin{array}{r} 403 \\ \times\ 59 \\ \hline \end{array}$$

4 A. 24 337
2 B. 5 642
86 C. 23 777
3 D. 3 627
3 E. I don't know.

1.1.5 R/40. Divide: $45\overline{)1232}$

9 A. 25 remainder 7
67 B. 27 remainder 17
9 C. 29 remainder 27
5 D. 207 remainder 17
8 E. I don't know.
3 Omit

1.1.6 S/1. By rounding off to the nearest ten, an estimate of 91 x 29 would be

13 A. 270
3 B. 279
71 C. 2 700
6 D. 27 000
6 E. I don't know.

1.1.7 S/2. If John had 2300 marbles, how many bags of 10 marbles each could he make?

10 A. 23
82 B. 230
3 C. 2 300
4 D. 23 000
1 E. I don't know.

1.1.8 S/3. Sue has 58¢. If apples cost 11¢ each, what is the greatest number of whole apples that Sue can buy?

2 A. 4
90 B. 5
2 C. 6
4 D. 47
1 E. I don't know.

1.1.9 S/4. As of June 1, 1976, the population of Canada was 22 589 416.
Round off 22 589 416 to the nearest ten thousand.

7 A. 22 580 000
8 B. 23 000 000
14 C. 22 600 000
69 D. 22 590 000
2 E. I don't know.

1.1.10 S/25. Simplify: $\frac{0}{6}$ =

46 A. 0
3 B. infinity
13 C. 6
33 D. cannot be done
5 E. I don't know.

1.1.11 T/1. The value of 572 + 18 005 + 73 is

91 A. 18 650
1 B. 96 410
1 C. 148 205
2 D. 186 410
4 E. I don't know.

1.1.12 T/2. The value of 3 + 4(5 + 2) is

5 A. 25
4 B. 26
11 C. 31
52 D. 49
27 E. I don't know.
2 Omit

1.1.13 T/3. Subtract: $\begin{array}{r} 2008 \\ -\underline{189} \end{array}$

7 A. 819
2 B. 1181
88 C. 1819
2 D. 2181
2 E. I don't know.

1.1.14 T/4. The greatest common factor of 24 and 30 is

6 A. 2
78 B. 6
11 C. 120
3 D. 60
3 E. I don't know.

1.1.15 T/47. Simplify: 4^3 =

3 A. 36
55 B. 64
29 C. 12
5 D. 32
5 E. I don't know.
3 Omit

Objective 1.2 Fractions & Decimals

1.2.1 R/14. Mrs. Smith baked 48 cookies. Billy ate $\frac{3}{8}$ of the cookies and Betty ate $\frac{1}{8}$ of the cookies. In all, how many cookies were eaten?

10 A. 16
7 B. 18
7 C. 20
66 D. 24
10 E. I don't know.
1 Omit

1.2.2 R/15. Subtract: 51.2 - 4.35

13 A. 46.95
70 B. 46.85
3 C. 17.7
9 D. 7.7
5 E. I don't know.

1.2.3 R/16. Which number is largest?

31 A. $\frac{2}{3}$
35 B. $\frac{4}{5}$
14 C. $\frac{3}{4}$
16 D. $\frac{5}{8}$
3 E. I don't know.

1.2.4 R/41. 3.008 written in words is

13 A. three hundred eight.
14 B. three thousand eight.
8 C. three and eight hundredths.
71 D. three and eight thousandths.
2 E. I don't know.
3 Omit

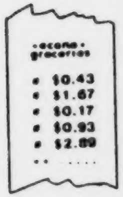
1.2.5 R/42. Which one of the following numbers is largest?

12 A. 0.694
9 B. 0.07
51 C. 0.76
25 D. 0.0816
2 E. I don't know.
3 Omit

1.2.6 R/43. Multiply: 0.01 x 2300

51 A. 23
5 B. 230
19 C. 2 300
17 D. 23 000
5 E. I don't know.
3 Omit

1.2.7 S/11. About how much will this grocery bill total?



5 A. between $3 and $4
91 B. between $6 and $7
2 C. between $9 and $10
1 D. between $12 and $15
1 E. I don't know.

1.2.8 S/12. John had 12 baseball cards. He gave $\frac{1}{3}$ of them to Jim. How many does John have left?

36 A. 4
4 B. 6
43 C. 8
14 D. 9
3 E. I don't know.

1.2.9 S/13. Divide: $.12\overline{)\,.036}$

15 A. 3
10 B. 0.003
61 C. 0.3
11 D. 0.03
3 E. I don't know.

1.2.10 S/26. Subtract: $7 - \frac{5}{6}$

8 A. $7\frac{1}{6}$
7 B. $7\frac{5}{6}$
21 C. $\frac{2}{6}$
54 D. $6\frac{1}{6}$
10 E. I don't know.

1.2.11 S/27. ESTIMATE the sum: 347.0 + 738.0 + 1.327

35 A. 1 000
19 B. 2 000
17 C. 10 000
21 D. 100 000
7 E. I don't know.
1 Omit

1.2.12 S/48. There are 13 boys and 15 girls in a group. What fraction of the group is boys?

8 A. $\frac{15}{28}$
45 B. $\frac{13}{15}$
7 C. $\frac{15}{13}$
34 D. $\frac{13}{28}$
2 E. I don't know.
3 Omit

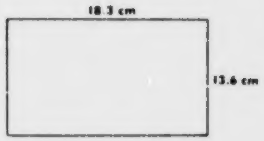
1.2.13 T/9. Add: $\frac{1}{2} + \frac{1}{3} =$

24 A. $\frac{2}{5}$
9 B. $\frac{1}{5}$
7 C. $\frac{1}{6}$
59 D. $\frac{5}{6}$
1 E. I don't know.

1.2.14 T/15. If 3 cakes are each cut into thirds, how many pieces are there?

1 A. 1
5 B. 3
5 C. 6
87 D. 9
2 E. I don't know.

1.2.15 T/16. The width of this rectangle is how much less than the length?



3 A. 4.3 cm
75 B. 4.7 cm
12 C. 5.3 cm
4 D. 5.7 cm
5 E. I don't know.

1.2.10 S/26. **Subtract:** $7 - \frac{5}{6}$

8 A. $7\frac{1}{6}$

7 B. $7\frac{5}{6}$

21 C. $\frac{2}{6}$

54 D. $6\frac{1}{6}$

10 E. I don't know.

1.2.11 S/27. ESTIMATE the sum: 347.0 + 738.0 + 1.327

35 A. 1 000
19 B. 2 000
17 C. 10 000
21 D. 100 000
7 E. I don't know.
1 Omit

1.2.12 S/48. There are 13 boys and 15 girls in a group. What fraction of the group is boys?

8 A. $\frac{15}{28}$

45 B. $\frac{13}{15}$

7 C. $\frac{15}{13}$

34 D. $\frac{13}{28}$

2 E. I don't know.

3 Omit

1.2.13 T/9. Add: $\frac{1}{2} + \frac{1}{3} =$

24 A. $\frac{2}{5}$

9 B. $\frac{1}{5}$

7 C. $\frac{1}{6}$

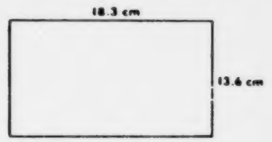
59 D. $\frac{5}{6}$

1 E. I don't know.

1.2.14 T/15. If 3 cakes are each cut into thirds, how many pieces are there?

1 A. 1
5 B. 3
5 C. 6
87 D. 9
2 E. I don't know.

1.2.15 T/16. The width of this rectangle is how much less than the length?



3 A. 4.3 cm
75 B. 4.7 cm
12 C. 5.3 cm
4 D. 5.7 cm
5 E. I don't know.

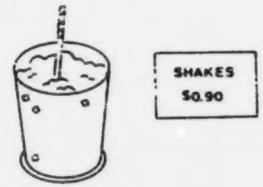
1.2.16 T/17. Written as a decimal, $\frac{1}{8}$ =

5 A. 0.12
34 B. 0.8
46 C. 0.125
10 D. 0.18
5 E. I don't know.

1.2.17 T/48. Multiply: $12 \times 2\frac{3}{4}$

6 A. $14\frac{3}{4}$
5 B. 30
45 C. 33
33 D. $24\frac{3}{4}$
8 E. I don't know.
3 Omit

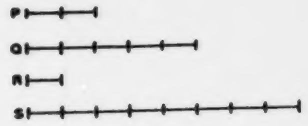
1.2.18 T/49. How many shakes can I buy with $4.20 ?



1 A. 2
5 B. 3
74 C. 4
15 D. 5
3 E. I don't know.
3 Omit

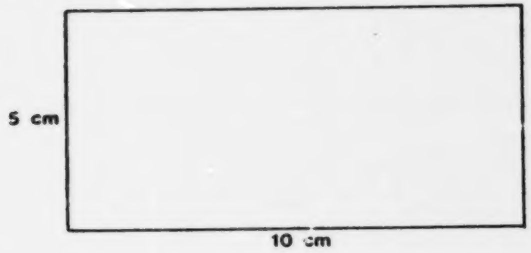
Objective 1.3 Ratio, Proportion & Percent

1.3.1 R/8. Which pair of line segments shown below have lengths which are in the ratio of 1 to 4?



20 A. P and Q
10 B. R and S
36 C. P and S
3 D. R and T
29 E. I don't know.
1 Omit

1.3.2 R/9. The following diagram of a playground is drawn to a scale of 1 cm = 2 m. What is the actual length of the longest side of the playground?



2 A. 2 m
9 B. 10 m
72 C. 20 m
12 D. 100 m
4 E. I don't know.

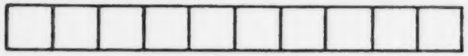
1.3.3 R/37. Written as a percent, $\frac{1}{5}$ =

16 A. 5%
18 B. 0.5%
57 C. 20%
4 D. 50%
3 E. I don't know.
2 Omit

1.3.4 S/19. What is 24% of $150.00?

8 A. $\frac{24}{100}$
9 B. $ 24.00
63 C. $ 36.00
4 D. $174.00
16 E. I don't know.

1.3.5 S/49. How many squares must be shaded to show 35% of the strip?



2 A. 0.035
21 B. 0.35
58 C. 3.5
5 D. 35
9 E. I don't know.
4 Omit

1.3.6 S/50. If 4 volleyballs cost $96.00, how much will 10 volleyballs cost?

29 A. $960.00
53 B. $240.00
3 C. $ 24.00
8 D. $384.00
3 E. I don't know.

1.3.7 T/10. If there are 300 calories in 900 g of a certain food, how many calories are there in a 300 g portion of that same food?

2 A. 27
5 B. 33
73 C. 100
6 D. 270
13 E. I don't know.

1.3.8 T/11. Which one of the following shows a discount of 10%?

77 A. 30¢ off $3
4 B. 35¢ off $3
7 C. 40¢ off $3
3 D. 45¢ off $3
9 E. I don't know.

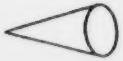
1.3.9 T/39. A map of B.C. is to be drawn so that 1 millimetre represents 5 kilometres. If the actual distance between Vernon and Penticton is 125 kilometres, how many millimetres apart should these two points be on the map?

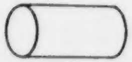
5 A. 125
10 B. 625
5 C. 120
69 D. 25
9 E. I don't know.
2 Omit

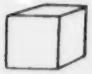
DOMAIN 2 Geometry

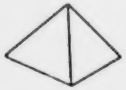
Objective 2.1 Geometric Figures

2.1.1 R/12. Which one of the following shapes is a cylinder?

10 A. 

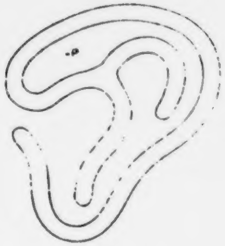
85 B. 

1 C. 

1 D. 

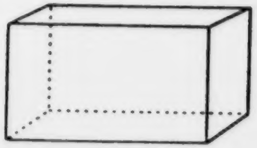
2 E. I don't know.

2.1.2 R/13. In the diagram to the right, point P is



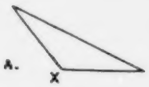
23 A. inside the figure.
47 B. outside the figure.
7 C. on the boundary of the figure.
19 D. neither inside, outside nor on the boundary of the figure.
3 E. I don't know.

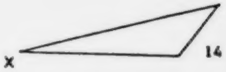
2.1.3 R/19. How many pairs of parallel planes are there in the following figure?

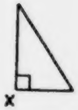


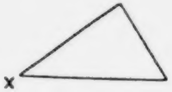
4 A. 2
22 B. 3
20 C. 4
48 D. 6
5 E. I don't know.
1 Omit

2.1.4 R/20. In which triangle is angle X an obtuse angle?

50 A. 

13 B. 

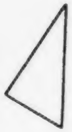
14 C. 

9 D. 

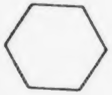
14 E. I don't know.
1 Omit

2.1.5 R/38. Which one of the following is a quadrilateral?

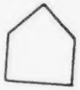
6 A.



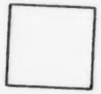
24 B.



22 C.



41 D.



5 E. I don't know.

2 Omit

2.1.6 R/39. Which one of the following is a measure of distance around a circle?

12 A. diameter

11 B. radius

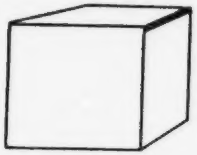
7 C. area

64 D. circumference

3 E. I don't know.

2 Omit

2.1.7 S/5. The heavy line shows one edge of the cube. How many edges does the cube have?



8 A. 6

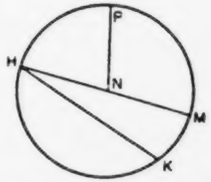
1 B. 5

20 C. 9

68 D. 12

2 E. I don't know.

2.1.8 S/6. If N is the centre, which segment is a diameter?



4 A. $\overline{HK}$

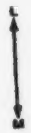
20 B. $\overline{NP}$

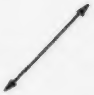
4 C. $\overline{HP}$

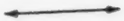
61 D. $\overline{HM}$

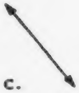
11 E. I don't know.

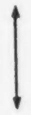
2.1.9 S/9. **Which one of the following lines appears perpendicular to $\overleftrightarrow{LM}$?**



4 A. 

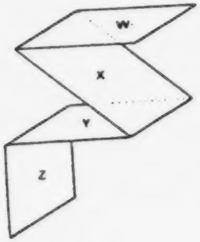
51 B. 

4 C. 

38 D. 

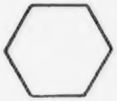
3 E. I don't know.

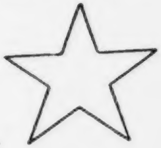
2.1.10 S/10. Which one of the following statements about the diagram shown below is INCORRECT?

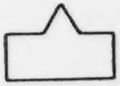


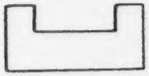
61 A. Plane X is parallel to plane Z.
8 B. Plane X is oblique to plane Y.
10 C. Plane W is parallel to plane Y.
9 D. Plane Z is perpendicular to plane Y.
11 E. I don't know.

2.1.11 S/20. **Which one of the following shapes has the same number of sides as an octagon?**

17 A. 

8 B. 

4 C. 

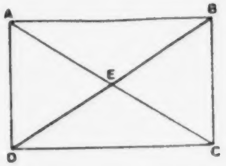
66 D. 

5 E. I don't know.

2.1.12 S/21. Lines that are in the same plane and do not intersect are called

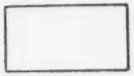
73 A. parallel lines.
8 B. perpendicular lines.
10 C. skew lines.
4 D. oblique lines.
5 E. I don't know.

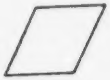
2.1.13 T/12. ABCD is a rectangle. Which segments are parallel?

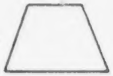


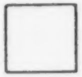
6 A. $\overline{AD}$ and $\overline{DC}$
12 B. $\overline{CA}$ and $\overline{DB}$
72 C. $\overline{CB}$ and $\overline{AD}$
5 D. $\overline{AE}$ and $\overline{EB}$
4 E. I don't know.
1 Omit

2.1.14 T/13. Which one of the following is NOT a parallelogram?

4 A. 

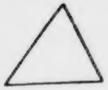
6 B. 

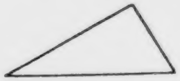
74 C. 

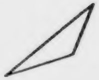
11 D. 

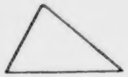
4 E. I don't know.
1 Omit

2.1.15 T/27. Which one of the following is most like a right triangle?

37 A. 

24 B. 

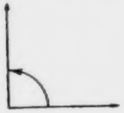
10 C. 

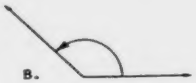
24 D. 

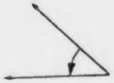
4 E. I don't know.

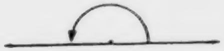
1 Omit

2.1.16 T/40. Which one of the following figures shows an acute angle?

16 A. 

8 B. 

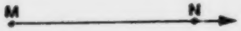
52 C. 

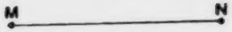
6 D. 

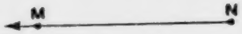
7 E. I don't know.

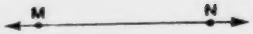
2 Omit

2.1.17 T/41. Which one of the following is a diagram of a line?

5 A. 

30 B. 

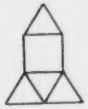
2 C. 

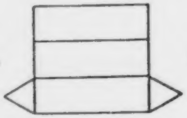
59 D. 

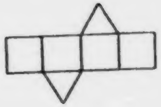
3 E. I don't know.

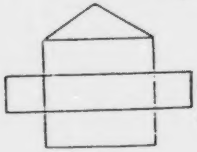
2 Omit

2.1.18 T/42. Which one of the following patterns can be made into a pyramid?

56 A. 

6 B. 

19 C. 

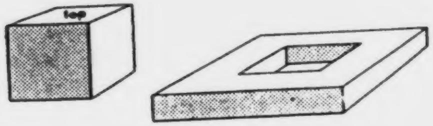
8 D. 

9 E. I don't know.

2 Omit

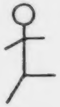
Objective 2.2 Geometric Relationships

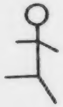
2.2.1 R/26. Keeping the top up, in how many different ways can the cube on the left be placed in the square hole in the figure on the right?

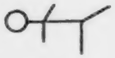


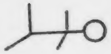
9 A. 8
48 B. 4
13 C. 2
25 D. 1
5 E. I don't know.
1 Omit

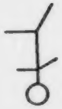
2.2.2 R/27. Which one of the following diagrams shows the flip image of the man shown to the right?



42 A.


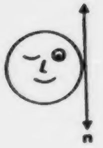
6 B.


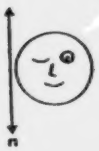
11 C.


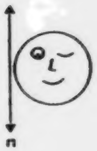
36 D.


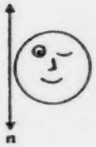
4 E. I don't know.

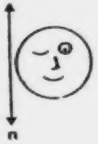
2.2.3 R/31. Which one of the following diagrams shows the reflection of the face in line n?



12 A.


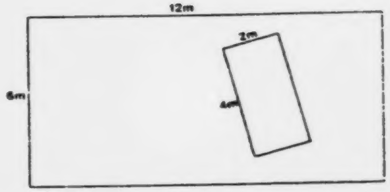
14 B.


58 C.


9 D.


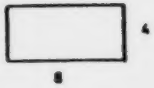
6 E. I don't know.
1 Omit

2.2.4 R/32. The mat and the floor shown on the right are similar shapes. How many mats would be needed to cover the floor?

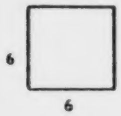


4 A. 4
16 B. 6
63 C. 9
11 D. 10
5 E. I don't know.
1 Omit

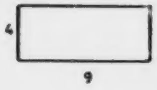
2.2.5 R/44. Which one of the following figures is congruent to the figure shown to the right?



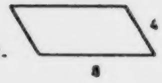
3 A.



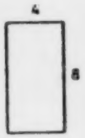
6 B.



20 C.

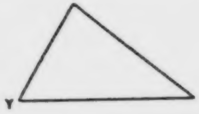


64 D.



4 E. I don't know.
3 Omit

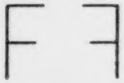
2.2.6 R/45. Estimate the number of degrees in angle Y of this triangle.



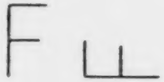
64 A. 60°
9 B. 90°
10 C. 30°
7 D. 120°
6 E. I don't know.
3 Omit

2.2.7 S/36. In which one of the following diagrams is the second figure a translation of the first?

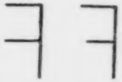
30 A.



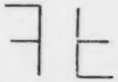
5 B.



42 C.



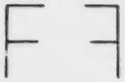
10 D.



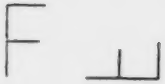
13 E. I don't know.
1 Omit

2.2.8 S/37. In which one of the following diagrams is the second figure a rotation of the first?

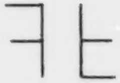
16 A.



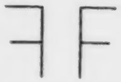
8 B.



29 C.

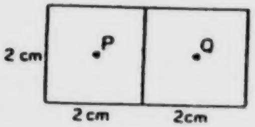


36 D.



9 E. I don't know.
1 Omit

2.2.9 S/39. P and Q are the centres of the 2 squares shown below. What is the distance in centimetres from P to Q?



5 A. 1

62 B. 2

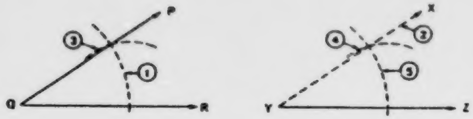
17 C. 4

7 D. $\sqrt{2^2 + 2^2}$

8 E. I don't know.

1 Omit

2.2.10 S/40. The diagram shown below illustrates a ruler-and-compass method of copying an angle. If the construction lines are labelled as shown in the figure, what order could be followed when completing the construction?



8 A. 1, 5, 2, 3 and 4

26 B. 1, 5, 3, 4 and 2

14 C. 1, 5, 3, 2 and 4

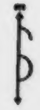
12 D. 1, 5, 4, 3 and 2

38 E. I don't know.

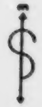
2 Omit

2.2.11 S/41. An incomplete figure is shown to the right.

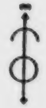
Which one of the following shows the completed figure, given that m is a line of symmetry?



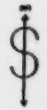
6 A.



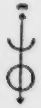
30 B.



51 C.



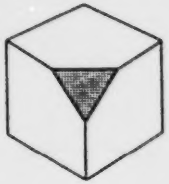
3 D.



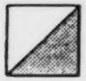
9 E. I don't know.

2 Omit

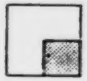
2.2.12 S/42. The figure to the right shows a cube with one corner cut off and shaded. Which one of the following drawings shows how the cube would look when viewed directly from above?



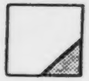
3 A.



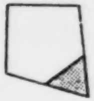
5 B.



71 C.



18 D.



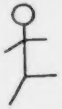
2 E. I don't know.

2 Omit

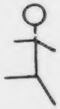
2.2.13 T/14. If two line segments are equal in length, they are

3 A. horizontal.
57 B. congruent.
28 C. parallel.
8 D. perpendicular.
3 E. I don't know.

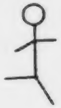
2.2.14 T/18. Which one of the following diagrams shows the slide image of the man shown to the right?



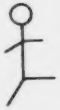
32 A.



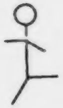
6 B.



50 C.

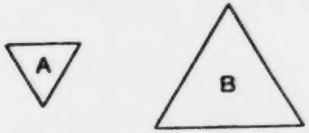


5 D.



7 E. I don't know.

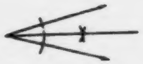
2.2.15 T/19. In the diagrams shown below, how many pieces the same size as A are needed to cover B?



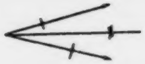
3 A. 2
38 B. 3
51 C. 4
6 D. 6
2 E. I don't know.

2.2.16 T/28. Which one of the following illustrates the correct procedure for bisecting an angle?

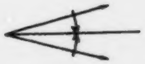
33 A.



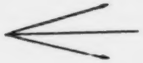
6 B.



37 C.



8 D.

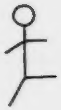


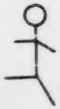
15 E. I don't know.
1 Omit

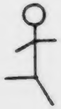
2.2.13 T/14. If two line segments are equal in length, they are

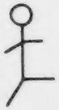
3 A. horizontal.
57 B. congruent.
28 C. parallel.
8 D. perpendicular.
3 E. I don't know.

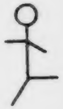
2.2.14 T/18. Which one of the following diagrams shows the slide image of the man shown to the right?



32 A. 

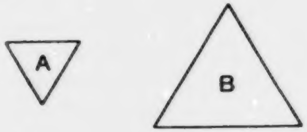
6 B. 

50 C. 

5 D. 

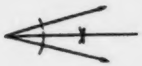
7 E. I don't know.

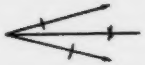
2.2.15 T/19. In the diagrams shown below, how many pieces the same size as A are needed to cover B?

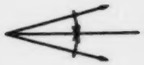


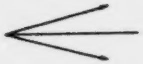
3 A. 2
38 B. 3
51 C. 4
6 D. 6
2 E. I don't know.

2.2.16 T/28. Which one of the following illustrates the correct procedure for bisecting an angle?

33 A. 

6 B. 

37 C. 

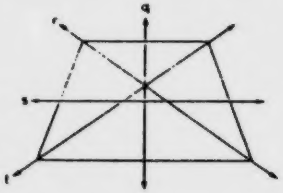
8 D. 

15 E. I don't know.
1 Omit

2.2.17 T/29. What is the diameter of a circle with a radius of 4?

62 A. 8
5 B. 6
7 C. 4
10 D. 2
15 E. I don't know.
1 Omit

2.2.18 T/43. Along which line can the trapezoid be folded exactly edge to edge and corner to corner?



46 A. q
11 B. r
15 C. s
10 D. t
16 E. I don't know.
2 Omit

DOMAIN 3 Measurement

Objective 3.1 Metric Units

3.1.1 R/21. 250 g is how many kilograms?

23 A. 25
4 B. 250
38 C. 0.25
19 D. 2.5
16 E. I don't know.

3.1.2 R/48. In the metric system, what does the prefix "centi" mean?

44 A. $\frac{1}{100}$ of the unit of measure
15 B. $\frac{1}{10}$ of the unit of measure
10 C. 10 times the unit of measure
15 D. 100 times the unit of measure
12 E. I don't know.
4 Omit

3.1.3 R/49. 5 metres is the same length as:

9 A. 50 centimetres
76 B. 500 centimetres
4 C. 50 millimetres
4 D. 500 millimetres
3 E. I don't know.
4 Omit

3.1.4 S/14. Which one of the following statements is true?

61 A. 100° C is the boiling point of water.
12 B. 212° C is the boiling point of water.
6 C. 32° C is the freezing point of water.
8 D. 10° C is the freezing point of water.
13 E. I don't know.

3.1.5 S/15. A ten-year-old boy is likely to weigh:

4 A. 35 grams
8 B. 75 grams
51 C. 35 kilograms
27 D. 75 kilograms
10 E. I don't know.

3.1.6 S/38. Which unit should be used to measure how much liquid a glass holds?

15 A. kilolitre
7 B. millimetre
4 C. metre
68 D. millilitre
4 E. I don't know.
1 Omit

3.1.7 T/35. Which unit would usually be used for the mass of sugar?

5 A. kL
4 B. km
83 C. kg
2 D. km^2
5 E. I don't know.
1 Omit

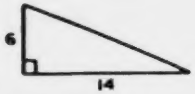
3.1.8 T/36. The temperature on a sunny summer day would most likely be:

3 A. 5° Celsius
50 B. 25° Celsius
20 C. 55° Celsius
21 D. 85° Celsius
5 E. I don't know.
1 Omit

3.1.9 T/37. The thickness of a dime is about:

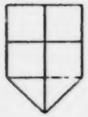
6 A. 1 cm
9 B. 1 dm
8 C. 1 m
73 D. 1 mm
3 E. I don't know.
2 Omit

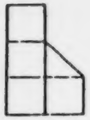
3.2.10 R/28. Find the area of this right triangle.

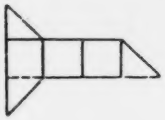


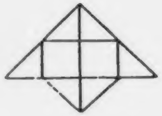
31 A. 42
14 B. 20
39 C. 84
3 D. 21
12 E. I don't know.
1 Omit

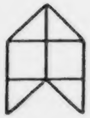
3.2.11 R/50. Which figure shown below has the same area as the figure shown on the right?



3 A. 

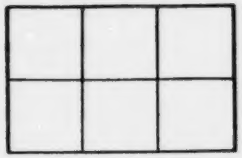
4 B. 

74 C 

11 D. 

5 E. I don't know.
4 Omit

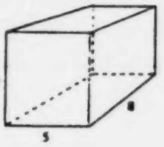
3.2.12 S/16. The area of each of the 6 SMALL squares shown below is 4.



What is the perimeter of the LARGE rectangle?

10 A. 10
10 B. 12
19 C. 20
50 D. 24
10 E. I don't know.

3.2.13 S/22. Find the volume of this box:

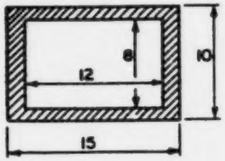


3 A. 30
8 B. 40
65 C. 240
13 D. 19
11 E. I don't know.

3.2.14 T/38. Mr. Jones put a fence around his rectangular garden. The garden is 10 m long and 6 m wide. How many metres of fencing did he use?

16 A. 16 m
3 B. 30 m
46 C. 32 m
31 D. 60 m
2 E. I don't know.
2 Omit

3.2.15 T/44. What is the area of the shaded portion of this figure?



30 A. 54
27 B. 96
9 C. 120
11 D. 60
20 E. I don't know.
3 Omit

DOMAIN 4 Algebraic Topics

Objective 4.1 Expressions, Equations & Inequalities

4.1.1 R/29. Of the following expressions, which one represents a number n increased by 5?

4 A. $5 - n$
70 B. $n + 5$
9 C. $5 < n$
6 D. $\frac{5}{n}$
9 E. I don't know.
1 Omit

4.1.2 R/30. "Mike paid x dollars for y metres of rope. How much did one metre cost?"

If x and y were given numerical values, which one of the following operations would you use to find the price of one metre of rope?

11 A. addition
9 B. subtraction
23 C. multiplication
49 D. division
6 E. I don't know.
1 Omit

4.1.3 R/33. $\Delta \times (\nabla + \square)$ is equal to

20 A. $\Delta \times \square + \nabla$
35 B. $\Delta \times \nabla + \square$
20 C. $(\Delta \times \nabla) + (\Delta \times \square)$
8 D. $(\Delta + \nabla) \times (\Delta + \square)$
15 E. I don't know.
2 Omit

4.1.4 R/34. The solution of $2n + 8 = 20$ is:

18 A. 12
4 B. 14
45 C. 6
17 D. 10
14 E. I don't know.
2 Omit

4.1.5 R/35. If $n = 5$, then $2n + 4 =$

51 A. 14
6 B. 18
10 C. 20
16 D. 11
15 E. I don't know.
2 Omit

4.1.6 R/36. Which one of the following expressions represents twice a number less 5?

5 A. $2x + 10$
14 B. $2x - 10$
52 C. $2x - 5$
7 D. $2x + 5$
19 E. I don't know.
2 Omit

4.1.7 S/23. Which one of the following is the same as "18 more than a number equals 44"?

11 A. $18n = 44$
8 B. $\frac{18}{n} = 44$
48 C. $n + 18 = 44$
11 D. $n = 18 + 44$
21 E. I don't know.

4.1.8 S/24. "How far will Jan walk if she walks at the rate of 1 kilometre in 10 minutes?"

What additional information is needed to solve this problem?

15 A. where she was going
17 B. how fast she was walking
61 C. how long she walked
3 D. how much she was carrying
3 E. I don't know.

4.1.9 S/30. To solve for b in the equation $2b + 3 = 10$, the first step should be to

8 A. divide both sides by 3.
28 B. multiply both sides by 2.
18 C. subtract 3 from both sides.
10 D. add 3 to both sides.
36 E. I don't know.
1 Omit

4.1.10 S/31. Which one of the following statements is NOT true?

13 A. $2a + a = 3a$
9 B. $3a - a = 2a$
35 C. $a + a = a$
21 D. $2a \div a = 2$
21 E. I don't know.
1 Omit

4.1.11 S/32. If $y = 15 - x$

what happens to y as x increases?

39 A. y decreases
16 B. y increases
17 C. y remains the same
13 D. cannot tell what happens to y
14 E. I don't know.
1 Omit

4.1.12 S/33. If x and y are odd numbers, what is true about $x + y$?

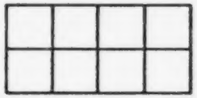
11 A. It is odd.
$\underline{50}$ B. It is even.
25 C. It may be either even or odd depending on what x and y are.
6 D. You cannot tell at all.
7 E. I don't know.
1 Omit

4.1.13 T/5. When the input is $\underline{x}$ the output is:

Input	Output
3	7
4	9
5	11
6	13
7	15
8	17
x	—

61 A. 19
2 B. 2x − 1
$\underline{15}$ C 2x + 1
9 D. x
12 E. I don't know.

4.1.14 T/24. If the measure of the side of each square is d units, how long is the rectangle?



18 A. 4 + d units
13 B. 8 + d units
$\underline{32}$ C. 4 x d units
26 D. 8 x d units
11 E. I don't know.

4.1.15 T/25. In the formula $\frac{I}{PT} = R$,
if I = 250, P = 1000, and T = 2, then R is

$\underline{30}$ A. $\frac{1}{8}$
12 B. $\frac{1}{2}$
8 C. 1
14 D. 50
36 E. I don't know.
1 Omit

4.1.16 T/26. Tom has y marbles and Mary has x marbles. Mary has more marbles than Tom. Which sentence shows this relation?

2 A. $x = y$
11 B. $x < y$
$\underline{80}$ C. $x > y$
3 D. $x > 2y$
3 E. I don't know.
1 Omit

4.1.17 T/45. $3n$ is equal to

21 A. $n + 3$
3 B. $n - 3$
$\underline{57}$ C. $n \times 3$
5 D. $n \div 3$
10 E. I don't know.
3 Omit

4.1.18 T/46. Which list contains all of the whole numbers which make this a true statement?

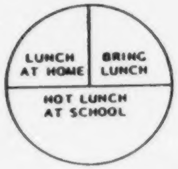
$$\boxed{p < 6}$$

16 A. 5
8 B. 7
20 C. 0,1,2,3,4,5,6
$\underline{34}$ D. 0,1,2,3,4,5
19 E. I don't know.
3 Omit

Objective 4.2 Graphs

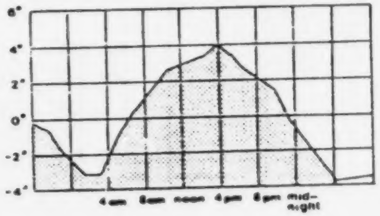
4.2.1 R/5. If 400 students eat lunch, about how many go home for lunch?

KINDS OF LUNCHES STUDENTS EAT



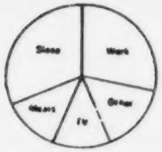
12 A. 25
66 B. 100
12 C. 200
2 D. 300
7 E. I don't know.

4.2.2 R/46. At what time did the highest temperature reading occur?



1 A. 3 am
2 B. 2 pm
91 C. 4 pm
2 D. midnight
1 E. I don't know.
3 Omit

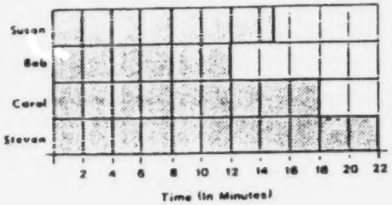
4.2.3 S/43. The graph below shows what a boy did during a period of 24 hours.



Which is the BEST estimate for the number of hours he spent watching TV?

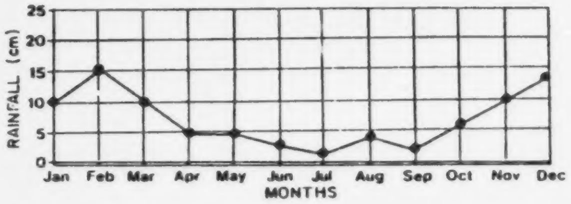
72 A. 3
14 B. 6
5 C. 9
4 D. 12
4 E. I don't know.
2 Omit

4.2.4 S/44. Pat was testing his model plane. His friends guessed how long it would stay in the air. The plane stayed up for 17 minutes. Who guessed closest to the correct time?



12 A. Susan
3 B. Bob
78 C. Carol
4 D. Steven
1 E. I don't know.
2 Omit

4.2.5 T/6. For how many months was the rainfall more than 5 cm?



7 A. 3

6 B. 4

81 C. 6

3 D. 9

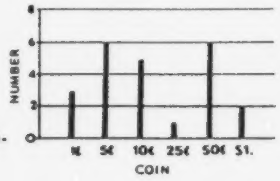
3 E. I don't know.

4.2.6 T/23. The table shows the numbers of various coins found in a box.

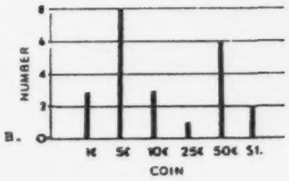
Coin	Number found
$1 (silver dollar)	2
50¢ (fifty-cent piece)	6
25¢ (quarter)	1
10¢ (dime)	3
5¢ (nickel)	8
1¢ (penny)	3

Which one of the following graphs shows this?

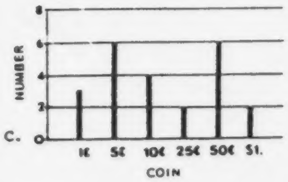
3 A.



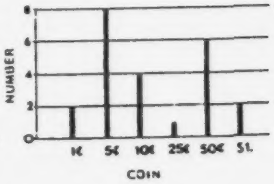
71 B.



4 C.



14 D.



8 E. I don't know.

5.1.1 R/6. Mike flips 2 dimes. What is the probability that they will both land heads?

20 A. $\frac{1}{4}$

5 B. $\frac{1}{3}$

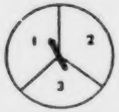
61 C. $\frac{1}{2}$

5 D. $\frac{2}{3}$

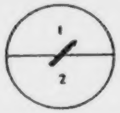
9 E. I don't know.

5.1.2 R/47. Four spinners are shown below. Suppose you LOSE the game if the pointer lands on 1. Which spinner would you choose?

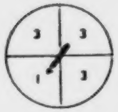
12 A.



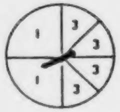
11 B.



53 C.



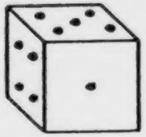
11 D.



9 E. I don't know.

4 Omit

5.1.3 S/17. If on the roll of a die the probability that a five will appear is $\frac{1}{6}$, then the probability that a five or a three will appear is:



21 A. $\frac{1}{6}$

4 B. $\frac{1}{36}$

47 C. $\frac{1}{3}$

14 D. $\frac{1}{12}$

14 E. I don't know.

2, 3, 4, 4, 5, 6, 8, 8, 9, 10

5.1.4 S/18. For a party game each number shown above was painted on a different Ping Pong ball, and the balls were thoroughly mixed up in a bowl. If a ball is picked from the bowl by a blindfolded person, what is the probability that the ball will have a 4 on it?

7 A. $\frac{1}{2}$

15 B. $\frac{1}{4}$

40 C. $\frac{1}{5}$

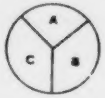
30 D. $\frac{1}{10}$

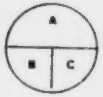
7 E. I don't know.

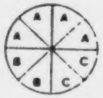
5.1.5 T/30. Sparky Spencer spun a spinner 100 times and made a record of his results.

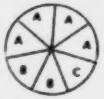
Outcome	A	B	C
Number of times	55	30	15

Which spinner did he most likely use?

9 A.


13 B.


12 C.


56 D.


9 E. I don't know.
1 Omit

5.1.6 T/31. If the probability that it will rain on a given day is 0.36, then the probability that it will NOT rain is:

9 A. 0.36
50 B. 0.64
24 C. 99.64
5 D. 99.36
11 E. I don't know.
1 Omit

Objective 5.2 Statistics

5.2.1 R/7. Which statistic tells you which event happened the most frequently?

18 A. mode
8 B. mean
17 C. median
14 D. range
43 E. I don't know.

5.2.2 R/10. The chart shows the population of the earth at different times.

Year	1650	1700	1750	1800	1850	1900	1950
Population in Billions	0.60	0.62	0.80	0.95	1.20	1.70	2.55

Which 50 year period showed the largest gain in population?

2 A. 1700-1750
3 B. 1800-1850
7 C. 1850-1900
84 D. 1900-1950
4 E. I don't know.

5.2.3 S/45. In four months, the volleyball team spent the following amounts travelling to games:

1st month - $17.95
2nd month - $22.40
3rd month - $ 8.25
4th month - $15.80

What was the average amount spent on travelling each month?

8 A. $10.10
21 B. $64.40
6 C. $32.20
56 D. $16.10
5 E. I don't know.
3 Omit

5.2.4 S/46. The median test mark was 37 out of 50. Billy scored 30 out of 50. How many children scored higher than Billy?

38 A. more than half
33 B. less than half
7 C. exactly half
4 D. none
15 E. I don't know.

5.2.5 T/7. Test marks: 3, 4, 5, 4, 5, 5, 5, 3, 3, 1, 4, 5, 0, 4, 5

Which one of the following tables represents this data?

24 A.

mark	frequency
0	1
1	1
2	0
3	3
4	4
5	6

10 B.

mark	frequency
0	1
1	2
2	1
3	3
4	3
5	6

12 C.

mark	frequency
0	1
1	1
2	0
3	3
4	4
5	5

12 D.

mark	frequency
0	0
1	1
2	2
3	3
4	4
5	5

41 E. I don't know.
1 Omit

5.2.6 T/32. The average age of 4 children is 6 years. If the ages of 3 of the children are 4 years, 8 years and 3 years, what is the age of the fourth child?

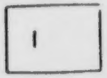
17 A. 6 years
35 B. 9 years
14 C. 7 years
22 D. 5 years
12 E. I don't know.
1 Omit

DOMAIN 6 Computers & Calculators

Objective 6.1 Computer Literacy

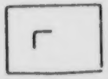
6.1.1 R/23. An imaginary computer can draw pictures on a television screen.
When given the instruction MOVE

it will draw a picture like this



When given the instruction MOVE R MOVE

it will draw this picture



Which one of the following sets of instructions would draw a square?

3 A. R R R R
9 B. MOVE R R R
5 C. MOVE MOVE MOVE MOVE
76 D. MOVE R MOVE R MOVE R MOVE
8 E. I don't know.
1 Omit

6.1.2 R/24. An imaginary computer will input two numbers and print their sum if these instructions are given to it:

```
TELL A
TELL B
WRITE A + B
```

What would the same computer print if given these instructions?

```
TELL A
TELL B
WRITE A * B
```

12 A. the sum of the numbers
43 B. the product of the numbers
14 C. the quotient of the numbers
7 D. the difference of the numbers
23 E. I don't know.
1 Omit

6.1.3 S/7. What is the numerical value of the computer language expression shown in the box below?

```
2 ↑ 3 - 2 * 3
```

16 A. 0
8 B. 2
23 C. 12
4 D. 18
49 E. I don't know.

6.1.4 S/8. An imaginary computer has commands called PRAX and ADDO

PRAX does the following:

Print out the value of X
Do the command called ADDO

ADDO does the following:

Add 2 to the current value of X
Do the command called PRAX

What will the following set of instructions do?

```
X = 2
PRAX
```

3 A. print out the odd numbers greater than 0
24 B. print out all integers greater than 2
26 C. print out the even numbers greater than 0
7 D. print out all integers less than 2
40 E. I don't know.

6.1.5 T/33. A list of instructions for a computer is called a

73 A. program.
8 B. disk.
9 C. terminal.
5 D. memory.
5 E. I don't know.
1 Omit

6.1.6 T/34. A set of instructions for an imaginary computer is as follows:

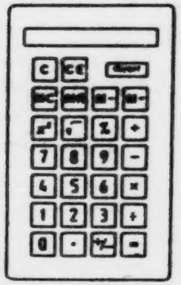
1. Arrange the three names Sandy, Dale, and Pat in alphabetical order
2. Remove the last name from the list
3. If only one name is left, stop, otherwise go on to step 4
4. Print out the names in reverse order
5. Go back to step 2

What will the computer print?

45 A. Pat
10 B. Dale, Pat
20 C. Dale, Pat, Sandy
15 D. Pat, Dale
9 E. I don't know.
1 Omit

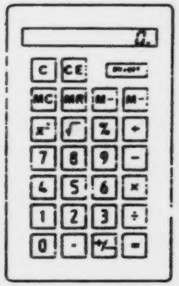
Objective 6.2 Calculator Use

6.2.1 R/11. Which one of the following keys would you push to get back the answer to a calculation which you had stored in the calculator?



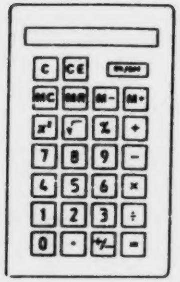
4 A. +/−
69 B. MR
12 C. M+
3 D. M−
12 E. I don't know.

6.2.2 R/22. You wish to calculate 6% of 85 on the calculator. Which one of the following sequences of keystrokes will likely give the correct answer?



34 A. 6 % × 8 5 =
9 B. 6 % 8 5
33 C. 8 5 ÷ 6 % =
16 D. 8 5 × 6 %
7 E. I don't know.

6.2.3 S/28. Which one of the following keys would you push to store the answer to a calculation so you could use it later on?



39 A. $\boxed{M+}$

41 B. $\boxed{MR}$

8 C. $\boxed{CE}$

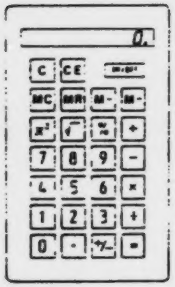
2 D. $\boxed{+}$

10 E. I don't know.

6.2.4 S/29. The following sequence of keystrokes is carried out on the calculator:

$\boxed{6}\boxed{3}\boxed{+}\boxed{7}\boxed{CE}\boxed{6}\boxed{=}$

What will likely be shown in the display?



38 A. $\boxed{6.}$

15 B. $\boxed{69.}$

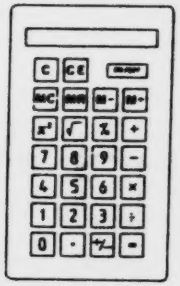
22 C. $\boxed{76.}$

6 D. $\boxed{636.}$

19 E. I don't know.

1 Omit

6.2.5 T/21. Think of a calculator as a person. A person's ears and eyes are like the calculator's



13 A. chip.

40 B. keys.

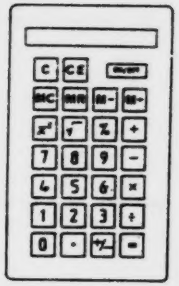
6 C. battery.

29 D. memory.

11 E. I don't know.

1 Omit

6.2.6 T/22. You wish to calculate the square root of 64 on the calculator. Which one of the following sequences of keystrokes will likely give the correct answer?



22 A. $\boxed{\sqrt{}}\boxed{6}\boxed{4}$

32 B. $\boxed{6}\boxed{4}\boxed{\sqrt{}}$

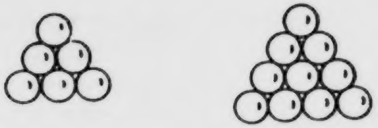
10 C. $\boxed{6}\boxed{4}\boxed{\times}\boxed{6}\boxed{4}\boxed{=}$

22 D. $\boxed{6}\boxed{4}\boxed{x^2}$

15 E. I don't know.

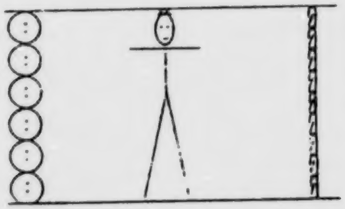
DOMAIN 7 Problem Solving

7.1.1 R/17. Marbles are arranged in the shape of a triangle on the floor. How many marbles are there in a triangle with 7 marbles in the base?



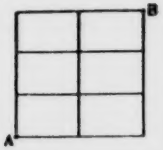
10 A. 12
65 B. 28
5 C. 42
6 D. 49
15 E. I don't know.

7.1.2 R/18. The stickman below is Mr. Big. He is 9 paper clips tall or 6 buttons tall. There is another stickman, Mr. Short, who is 6 paper clips tall. How many buttons tall would he be?



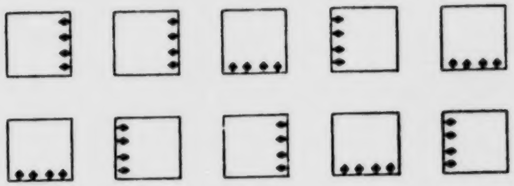
2 A. $1\frac{1}{2}$
33 B. 3
60 C. 4
2 D. 5
2 E. I don't know.

7.1.3 R/25. How many different routes are there from A to B? You may travel only up and to the right.



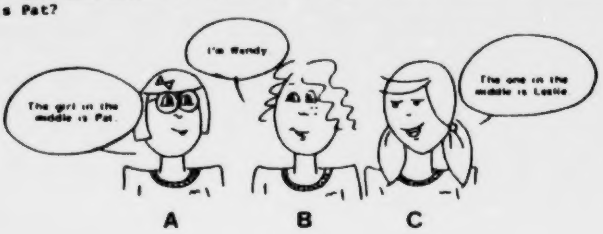
43 A. 8
26 B. 10
9 C. 15
11 D. 18
9 E. I don't know.
1 Omit

7.1.4 S/34. What is the minimum number of tiles that must be turned so that they are all facing the same way?



25 A. 4
7 B. 5
53 C. 6
6 D. 11
9 E. I don't know.
1 Omit

7.1.5 S/35. Three tennis players named Pat, Wendy and Leslie are walking to the courts. Pat, the best player of the three, always tells the truth. Wendy sometimes tells the truth, while Leslie never tells the truth. Who is Pat?

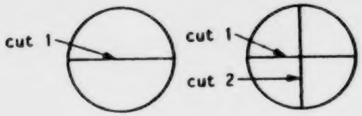

The girl in the middle is Pat.
I'm Wendy
The one in the middle is Leslie
A
B
C

13 A. A
15 B. B
49 C. C
15 D. either A or B
6 E. I don't know.
1 Omit

7.1.6 S/47. I am thinking of two numbers. When you add them you get 36. When you subtract them you get 8. To find both numbers the most useful problem-solving technique would be to

27 A. guess and check.
13 B. draw a picture or diagram.
8 C. solve a simpler problem.
42 D. work backwards.
6 E. I don't know.
3 Omit

7.1.7 T/8. In the diagram shown below, a cake is cut so that all cuts are made through the center. To find how many pieces there will be after 10 cuts, the most useful problem-solving technique would be to

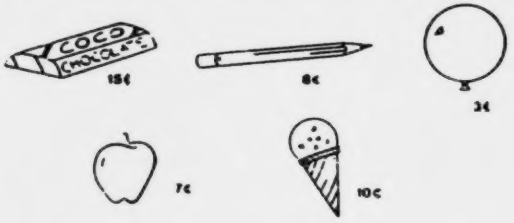


65 A. look for a pattern.
7 B. solve a simpler problem.
12 C. guess and check.
8 D. work backwards.
7 E. I don't know.

7.1.8 T/20. I am a number between 25 and 40. I have a remainder of two when divided by both 6 and by 9. Who am I?

6 A. 26
7 B. 29
12 C. 32
61 D. 38
14 E. I don't know.
1 Omit

7.1.9 T/50. Joyce has 50¢. Which of the following can she buy?



8 A. 3 apples and 3 ice cream cones

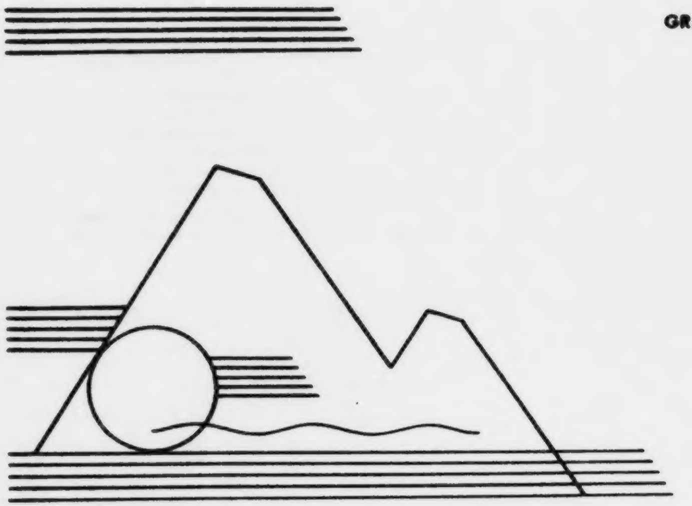
65 B. 5 apples and 3 balloons

5 C. 4 ice cream cones and a chocolate bar

6 D. 3 chocolate bars and a pencil

11 E. I don't know.

4 Omit



BRITISH COLUMBIA

MATHEMATICS ASSESSMENT 1985

GRADE 10 **10**

STUDENT BACKGROUND INFORMATION

1. What language did you first learn to speak?

79.4 A. English
1.2 B. French
13.8 C. Another language

2. What language do you speak most often in your home now?

86.7 A. English
0.7 B. French
6.9 C. Another language

3. What program are you in?

88.2 A. Regular Program
1.6 B. Early French Immersion
1.4 C. Late French Immersion
0.4 D. "Programme-Cadre de Français"

4. Have you completed or are you currently taking Consumer Education 9/10?

68.2 A. Yes
25.7 B. No

5. How long did it take you to do your last mathematics homework assignment?

5.2 A. We don't have homework in this class.
5.8 B. Between 1 and 10 minutes
16.5 C. Between 11 and 30 minutes
44.9 D. Between 31 and 60 minutes
16.3 E. More than an hour

6. About how much time did you spend doing homework in all subjects yesterday?

26.1 A. I didn't have any homework to do yesterday.
14.8 B. Less than 30 minutes
23.1 C. Between 30 minutes and 1 hour
20.2 D. From 1 to 2 hours
9.9 E. More than 2 hours

7. At what grade level is the mathematics course you are now taking?

0.2 A. 8
0.6 B. 9
88.0 C. 10
1.2 D. 11
0.1 E. 12
4.1 F. I am not taking mathematics now.

8. When did the mathematics class you are taking now begin?

4.4 A. I'm not taking a mathematics course right now.
76.3 B. September, 1984
11.3 C. January or February, 1985
1.7 D. Other

9. Was the Mathematics 10 course you either took earlier this year or are currently taking designed to prepare you to take Algebra 11?

73.1 A. Yes
19.2 B. No
1.1 C. I have not taken Math 10.

10. Which mathematics courses do you plan to take in Grade 11? (Mark all that apply.)

A. None
B. Math 10
C. Algebra 11
D. Trades Math 11
E. Business and Consumer Math 11
F. Computer Science 11
G. Algebra 12
H. Geometry 12
I. Probability and Statistics 12

11. Which mathematics courses do you plan to take in Grade 12? (Mark all that apply.)

A. None
B. Algebra 11
C. Trades Math 11
D. Business and Consumer Math 11
E. Computer Science 11
F. Algebra 12
G. Geometry 12
H. Probability and Statistics 12

12. What do you plan to do after leaving secondary school?

A. Attend a business school or a technical institute
B. Attend a vocational, art or trade training school
C. Attend a community college: university transfer program
D. Attend a community college: career program
E. Attend a university
F. Look for a full-time job
G. Take a year off and then return to school
H. Take a year off and then look for a job
I. Other plans
J. Undecided

13. What was the highest level of school or college attended by your father or male guardian?

2.5 A. Very little or no schooling at all
6.6 B. Elementary school
35.3 C. Secondary school
33.5 D. College, university or some other form of post-secondary training
14.4 E. I don't know.

14. What was the highest level of school or college attended by your mother or female guardian?

2.3 A. Very little or no schooling at all
4.5 B. Elementary school
41.7 C. Secondary school
31.8 D. College, university or some other form of post-secondary training
11.9 E. I don't know.

15. Here is a list of reasons for studying mathematics. Which do you believe is most important?

14.2 A. To prepare for the next year's mathematics course
11.0 B. To learn how to perform calculations accurately
47.9 C. To learn how to use mathematics to solve problems in the real world
16.2 D. To learn to think logically
3.2 E. To learn what mathematics is

16. Which of these reasons for studying mathematics do you believe to be least important?

18.1 A. To prepare for the next year's mathematics course
4.0 B. To learn how to perform calculations accurately
6.2 C. To learn how to use mathematics to solve problems in the real world
15.6 D. To learn to think logically
48.9 E. To learn what mathematics is

Both answers given for questions 17-20 are correct. If you were asked each question, which one of the two answers comes to your mind first?

17. How much does a bicycle weigh?

25.6 A. About 15 kilograms
67.3 B. About 35 pounds

18. What is the temperature in this room?

39.0 A. About 70 degrees
53.9 B. About 20 degrees

19. How far is it from Prince George to Prince Rupert?

30.2 A. About 700 kilometres
62.7 B. About 450 miles

20. How much gasoline can the gas tank in a large car hold?

58.6 A. About 20 gallons
34.4 B. About 90 litres

SCALE B: MATHEMATICS IN SCHOOL

For each of the items in this scale, three answers are needed.

A. Tell how important you think the topic is.
B. Tell how how easy it is.
C. Tell how much you like the topic.

If you are not sure what a topic means, leave its three answers blank.

1. Solving equations

A.		B.		C.	
1.5	not at all important	2.2	very difficult	5.3	dislike a lot
5.1	not important	24.9	difficult	22.1	dislike
11.1	undecided	22.0	undecided	23.4	undecided
61.5	important	45.0	easy	44.3	like
20.8	very important	5.9	very easy	4.9	like a lot

2. Finding area and volume

A.		B.		C.	
2.9	not at all important	3.8	very difficult	7.6	dislike a lot
12.3	not important	24.9	difficult	31.0	dislike
17.9	undecided	18.2	undecided	26.5	undecided
55.0	important	44.3	easy	32.1	like
12.0	very important	8.7	very easy	2.8	like a lot

3. Working with fractions, decimals and percent

A.		B.		C.	
1.0	not at all important	2.8	very difficult	5.8	dislike a lot
3.0	not important	17.3	difficult	20.6	dislike
6.4	undecided	16.1	undecided	21.4	undecided
51.7	important	48.6	easy	43.6	like
37.8	very important	15.3	very easy	8.6	like a lot

4. Factoring

	A.		B.		C.
5.8	not at all important	2.6	very difficult	6.9	dislike a lot
25.6	not important	19.4	difficult	27.0	dislike
29.6	undecided	23.2	undecided	27.8	undecided
34.0	important	43.9	easy	32.8	like
5.0	very important	10.9	very easy	5.5	like a lot

5. Constructing geometric figures

	A.		B.		C.
10.6	not at all important	5.8	very difficult	11.4	dislike a lot
26.3	not important	23.0	difficult	26.7	dislike
26.2	undecided	24.4	undecided	22.8	undecided
30.7	important	35.2	easy	30.1	like
6.2	very important	11.6	very easy	9.0	like a lot

6. Working with exponents

	A.		B.		C.
5.3	not at all important	1.9	very difficult	5.2	dislike a lot
19.6	not important	15.6	difficult	22.0	dislike
28.1	undecided	24.2	undecided	32.1	undecided
41.9	important	47.3	easy	35.6	like
5.2	very important	11.0	very easy	5.0	like a lot

7. Constructing graphs

	A.		B.		C.
6.0	not at all important	2.4	very difficult	6.9	dislike a lot
16.8	not important	12.2	difficult	18.6	dislike
19.0	undecided	15.1	undecided	18.5	undecided
46.9	important	50.8	easy	44.1	like
11.4	very important	19.6	very easy	11.9	like a lot

8. Estimating answers

	A.		B.		C.
5.1	not at all important	1.3	very difficult	5.0	dislike a lot
13.8	not important	11.3	difficult	19.1	dislike
18.7	undecided	23.2	undecided	31.8	undecided
47.2	important	48.1	easy	37.4	like
15.1	very important	16.1	very easy	6.7	like a lot

9. Solving word problems

	A.		B.		C.
8.5	not at all important	16.2	very difficult	22.8	dislike a lot
14.2	not important	35.3	difficult	28.2	dislike
15.9	undecided	20.1	undecided	17.5	undecided
43.4	important	24.3	easy	24.7	like
18.0	very important	4.1	very easy	6.8	like a lot

10. Working with congruent and similar figures

	A.		B.		C.
9.8	not at all important	4.8	very difficult	10.6	dislike a lot
22.2	not important	22.8	difficult	27.3	dislike
38.8	undecided	40.7	undecided	40.5	undecided
26.7	important	27.3	easy	19.0	like
2.6	very important	4.3	very easy	2.6	like a lot

SCALE 5: GENDER AND MATHEMATICS

For each of these items choose the answer which best describes how you feel.

1. Men make better scientists and engineers than women.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
27.8	42.0	15.1	12.5	2.6

2. Girls have more natural ability in mathematics than boys.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
18.6	49.3	22.2	8.4	1.4

3. Boys need to know more mathematics than girls.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
25.4	48.7	13.9	10.4	1.6

4. A woman needs a career just as much as a man does.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
2.8	6.3	7.4	44.6	38.9

5. My father enjoys doing mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
8.6	19.3	32.0	30.3	9.8

6. My mother enjoys doing mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
10.6	29.8	32.7	22.4	4.5

7. My father is usually able to help me with my mathematics homework if I ask him to help.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
14.5	23.1	14.4	34.0	14.0

8. My mother is usually able to help me with my mathematics homework if I ask her to help.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
16.5	31.2	15.9	29.9	6.5

9. My mother thinks that learning mathematics is important for me.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
1.4	2.0	9.3	49.4	38.7

10. My father thinks that learning mathematics is important for me.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
1.2	1.9	10.8	45.4	40.7

11. My father wants me to do well in mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
0.9	0.9	8.4	49.4	40.1

12. My mother wants me to do well in mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
0.7	1.0	5.7	52.2	40.4

13. Girls can do better than boys in mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
20.5	39.8	26.0	10.7	3.0

14. My mother is usually very interested in helping me with mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
10.5	32.4	28.9	23.4	4.7

15. My father is usually very interested in helping me with mathematics.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
9.2	22.9	30.0	28.8	9.1

SCALE T: CALCULATORS AND COMPUTERS

1. Do you own a calculator?

85.5 A. Yes
14.5 B. No

2. How often do you use a calculator outside school?

17.8 A. Never
45.8 B. Rarely (about once a week)
31.8 C. Sometimes (a couple of times a week)
4.6 D. Frequently (almost every day)

3. How often do you use a calculator in school?

25.6 A. Never
30.6 B. Rarely (about once a week)
30.0 C. Sometimes (a couple of times a week)
13.8 D. Frequently (almost every day)

4. Choose the one answer which best describes how your class used calculators on mathematics tests this year.

40.9 A. Not at all; we weren't allowed to use them on tests.
37.1 B. We were allowed to use them on some tests, if we wanted to.
15.5 C. We were allowed to use them on all tests, if we wanted to.
6.6 D. We were required to use them on some tests.

5. In what ways do you use a calculator to do mathematics in this class? (Mark all that apply.)

18.1 A. Not at all; we're not allowed to use calculators in this class.
61.7 B. To calculate answers to problems
39.9 C. To check answers
3.4 D. For games and fun

6. Some people say that Grade 10 students should NOT be allowed to use calculators in school. How do you feel about this?

25.7 A. Strongly Disagree
46.3 B. Disagree
18.7 C. Undecided
7.8 D. Agree
1.5 E. Strongly Agree

7. Some people say that if students are allowed to use calculators, then it should NOT be necessary for them to learn how to add, subtract, multiply, or divide by hand. How do you feel about this?

55.8 A. Strongly Disagree
28.9 B. Disagree
8.5 C. Undecided
4.7 D. Agree
2.1 E. Strongly Agree

8. Do you have a computer (one that will do more than play games) at home?

29.4 A. Yes
69.3 B. No
1.3 C. I don't know.

9. What have you used a computer to do? (Mark all that apply.)

14.2 A. Nothing, I've never used a computer.
55.4 B. To play games
19.4 C. To write stories or letters
34.8 D. To write my own programs
19.0 E. To learn about mathematics or other subjects

10. Where did you get most of your experience with computers?

25.6 A. I haven't had any experience with computers.
24.0 B. At home
50.4 C. In courses taken at school or elsewhere

FOR ITEMS 11-20, CHOOSE THE ANSWER THAT BEST DESCRIBES YOUR OPINION.

11. I would like to learn more about computers.

2.6 A. Strongly Disagree
4.3 B. Disagree
17.2 C. Undecided
46.7 D. Agree
29.3 E. Strongly Agree

12. I feel helpless around computers.

14.1 A. Strongly Disagree
38.7 B. Disagree
24.4 C. Undecided
18.7 D. Agree
4.2 E. Strongly Agree

13. Every student should be taught, in school, how to use a computer.

3.4 A. Strongly Disagree
10.4 B. Disagree
19.2 C. Undecided
44.4 D. Agree
22.7 E. Strongly Agree

14. Computers can be used to teach mathematics.

2.8 A. Strongly Disagree
7.1 B. Disagree
17.9 C. Undecided
54.6 D. Agree
17.5 E. Strongly Agree

15. Computers can be used to teach subjects other than mathematics.

2.8 A. Strongly Disagree
5.6 B. Disagree
16.0 C. Undecided
57.1 D. Agree
18.4 E. Strongly Agree

16. Using computers is more suitable for boys than for girls.

59.8 A. Strongly Disagree
27.6 B. Disagree
7.6 C. Undecided
2.4 D. Agree
2.5 E. Strongly Agree

17. I feel confident about being able to use computers.

4.7 A. Strongly Disagree
15.5 B. Disagree
32.1 C. Undecided
38.8 D. Agree
9.0 E. Strongly Agree

18. I enjoy using computers.

3.0 A. Strongly Disagree
6.6 B. Disagree
25.1 C. Undecided
47.2 D. Agree
18.1 E. Strongly Agree

19. Computers are gaining too much control over people's lives.

8.5 A. Strongly Disagree
25.4 B. Disagree
28.5 C. Undecided
25.1 D. Agree
12.3 E. Strongly Agree

20. I am able to work with computers as well as most others my age.

6.7 A. Strongly Disagree
28.6 B. Disagree
27.9 C. Undecided
29.2 D. Agree
7.6 E. Strongly Agree

Third Assessment of Mathematics

Grade 10 1985

"ORGANIZATION OF TEST ITEMS"

Objective		Test Items	Page No.
	Domain 1: Number and Operations		
1.1	Number Concepts	R: 1,2,3 S: 1,2,3 T: 1,2,3	
1.2	Fractions and Decimals	R: 10,25,26,27 S: 15,16,17,26 T: 4,39,40,41	
1.3	Ratio, Proportion and Percentages	R: 11,12,39,40,41 S: 27,28,29,33,34 T: 19,26,27,28,29	
	Domain 2: Geometry		
2.1	Geometric Figures	R: 20,21,42 S: 35,48,49 T: 7,8,20	
2.2	Geometric Relationships	R: 17,28,29,34,35 S: 20,21,30,41,42 T: 13,14,15,16,42	
	Domain 3: Measurement		
3.1	Metric Units	R: 18,22 S: 31,32 T: 21,43	
3.2	Perimeter, Area and Volume	R: 7,8,9, 19, 36 S: 4,5,6,24,25 T: 5,6,22,23,44	
	Domain 4: Algebraic Topics		
4.1	Expressions, Equations & Inequalities	R: 37,38,45,46,47,48,49 S: 37,38,39,40,45,46,47 T: 17,30,31,32,36,37,38	
4.2	Graphs	R: 15,16,23 S: 10,18,19 T: 18,24,47	

Objective		Test Items	Page No.
	* **Domain 5: Probability & Statistics**		
5.1	Probability	R: 24,50 S: 7,11 T: 9,25	
5.2	Statistics	R: 4,32,33 S: 8,9,36 T: 10,45,48	
	* **Domain 6: Computers and Calculators**		
6.1	Computer Literacy	R: 30,31 S: 12,44 T: 11,35	
6.2	Calculator Use	R: 6,13,14 S: 22,23,43 T: 33,34,46	
7.1	**Domain 7: Problem Solving**	R: 5,43,44 S: 13,14,50 T: 12,49,50	

* Domains 5 and 6 are not based on current curriculum.

1985 Mathematics Assessment Test Booklet Summary

Grade 10 - Form R

Item#	Objective#	Change Domain	1981 Gr.4#	1985 Gr.7#	1985 Gr.10#
1	1.1	1	B/11		S/48
2	1.1	1	B/20		
3	1.1				
4	5.2	5	A/03		
5	7				
6	6.2				
7	3.2				
8	3.2	3	B/21		
9	3.2				
10	1.2				
11	1.3	1	A/10		
12	1.3				
13	6.2				R/11
14	6.2				
15	4.2	4	A/34		
16	4.2	4	B/01		
17	2.2				
18	3.1	3	B/41		
19	3.2				
20	2.1	2	B/16		
21	2.1	2	B/27	R/37	S/05
22	3.1	3	B/12	S/14	R/49
23	4.2				
24	5.1				
25	1.2				
26	1.2	1	B/34		R/16
27	1.2	1	B/15		
28	2.2				
29	2.2	2	A/18		
30	6.1			R/44	R/23
31	6.1				S/08
32	5.2	5	A/16		
33	5.2	5	B/35		
34	2.2				
35	2.2	2	B/32		
36	3.2	3	A/43		
37	4.1				
38	4.1	4	B/39		
39	1.3	1	B/04		
40	1.3				
41	1.3				
42	2.1				
43	7				S/35
44	7			R/12	T/20
45	4.1	4	A/45		
46	4.1	4	B/42		
47	4.1	4	B/07		
48	4.1				
49	4.1	4	B/23		
50	5.1	5	B/06		

1985 Mathematics Assessment Test Booklet Summary

Grade 10 - Form S

Item#	Objective#	Change Domain	1981 Gr.4#	1985 Gr.7#	1985 Gr.10#
1	1.1	1	A/06		
2	1.1				
3	1.1	1	A/12		
4	3.2	3	A/27		
5	3.2				
6	3.2				
7	5.1	5	B/37		T/31
8	5.2	5	B/36		
9	5.2				
10	4.2	4	A/44		
11	5.1	5	A/04		S/17
12	6.1				S/07
13	7				
14	7				
15	1.2	1	A/08		
16	1.2				
17	1.2	1	B/24		
18	4.2	4	B/14		
19	4.2				
20	2.2				
21	2.2	2	A/36		
22	6.2				T/22
23	6.2				S/29
24	3.2	3	A/32		
25	3.2				
26	1.2				
27	1.3				
28	1.3	1	A/24		
29	1.3				
30	2.2				
31	3.1	3	B/08		
32	3.1	3	A/13	R/06	S/15
33	1.3				
34	1.3				
35	2.1				
36	5.2				
37	4.1				
38	4.1				
39	4.1				
40	4.1				
41	2.2				
42	2.2	2	A/42		
43	6.2				T/21
44	6.1				T/34
45	4.1	4	B/38		
46	4.1				
47	4.1	4	A/39		
48	2.1	2	A/26		S/06
49	2.1	2	A/29		
50	7				S/34

1985 Mathematics Assessment Test Booklet Summary

Grade 10 - Form T

Item#	Objective#	Change Domain	1981 Gr.4#	1985 Gr.7#	1985 Gr.10#
1	1.1	1	B/10		
2	1.1	1	A/30		
3	1.1				
4	1.2	1	A/22		
5	3.2				
6	3.2	3	B/17		
7	2.1				
8	2.1				
9	5.1	5	B/33		
10	5.2				
11	6.1				
12	7				R/17
13	2.2	2	B/43		
14	2.2	2	B/18		
15	2.2				
16	2.2				
17	4.1				
18	4.2	4	B/30		
19	1.3				
20	2.1	2	B/26		R/20
21	3.1	3	A/19		
22	3.2	3	A/23		T/44
23	3.2				
24	4.2				
25	5.1	5	A/35		R/06
26	1.3	1	B/09		R/37
27	1.3				
28	1.3	1	B/45		
29	1.3				
30	4.1	4	A/41		
31	4.1	4	A/28		
32	4.1	4	B/44		
33	6.2				S/28
34	6.2				
35	6.1			R/43	T/33
36	4.1	4	A/25		
37	4.1				
38	4.1				
39	1.2				
40	1.2				
41	1.2				
42	2.2				
43	3.1			R/42	
44	3.2	3	B/40		
45	5.2				
46	6.2				R/22
47	4.2				
48	5.2				
49	7				R/25
50	7				

DOMAIN 1 Number & Operations

Objective 1.1 Number Concepts

1.1.1 R/1. **There are 13 boys and 15 girls in a group. What fraction of the group is boys?**

6 A. $\frac{15}{28}$

50 B. $\frac{13}{15}$

6 C. $\frac{15}{13}$

36 D. $\frac{13}{28}$

1 E. I don't know.

1.1.2 R/2. The closest estimate for $\sqrt{640}$ would be

8 A. 20
6 B. 30
39 C. 25
38 D. 80
9 E. I don't know.

1.1.3 R/3. A used automobile can be bought for cash for $2850, or on credit with a downpayment of $400 and $80 a month for three years. How much more would a person pay by buying on credit than by buying the car for cash?

11 A. $3280
10 B. $ 640
55 C. $ 430
9 D. $ 400
13 E. I don't know.
1 Omit

1.1.4 S/1. **Expressed in scientific notation, the depth of a certain part of the ocean is 3.6×10^2 metres. What is the value of 3.6×10^2?**

2 A. 36
24 B. 3600
1 C. 1296
69 D. 360
3 E. I don't know.

1.1.5 S/2. Estimate the answer to $12\frac{2}{35} \times 5\frac{16}{17} \times 10$

(Do not take time to perform the calculation.)

3 A. 27
35 B. 600
38 C. 720
11 D. 780
13 E. I don't know.
1 Omit

1.1.6 S/3. 31.8 L is a measurement which has been rounded to the nearest tenth. Which of the following is NOT a possible value for the measurement before it was rounded?

6 A. 31.76 L
9 B. 31.90 L
54 C. 31.749 L
26 D. 31.849 L
5 E. I don't know.
1 Omit

1.1.7 T/1. **Estimate the product: 49.72 x 8.46 x 9.98**
(Do not take time to perform the calculation.)

5 A. 400
40 B. 4000
24 C. 3900
23 D. 5000
7 E. I don't know.
1 Omit

1.1.8 T/2. **Simplify: 30 - 4(8 - 2)**

6 A. 0
10 B. 20
24 C. 156
54 D. 6
5 E. I don't know.
1 Omit

1.1.9 T/3. **Which one of the following numbers is smallest?**

36 A. 0.625
11 B. 0.25
1 C. 0.375
50 D. 0.125
1 E. I don't know.

Objective 1.2 Fractions & Decimals

1.2.1 R/10. **Mrs. Schmidt works in a local factory for $6.00 per hour, plus time and one-half after 40 hours. Last week she worked 45 hours. How much did she earn?**

31 A. $240
21 B. $270
62 C. $285
5 D. $405
7 E. I don't know.
1 Omit

1.2.2 R/25. **Subtract: $53.52 - $27.86**

2 A. $34.34
3 B. $36.66
3 C. $25.38
90 D. $25.66
2 E. I don't know.
1 Omit

1.2.3 R/26. **Which number is largest?**

29 A. $\frac{2}{3}$
44 B. $\frac{4}{5}$
17 C. $\frac{3}{4}$
7 D. $\frac{5}{8}$
3 E. I don't know.
1 Omit

1.2.4 R/27. Tennis balls are on sale at 4 sports shops. You would pay the lowest price per ball if you bought at the store which offers

13 A. 8 tennis balls for $7.25

21 B. 1 dozen balls for $11.00

7 C. tennis balls for $0.95 each

51 D. 3 tennis balls for $2.70

6 E. I don't know.

1 Omit

1.2.5 S/15. Divide: $\frac{2}{3} \div \frac{5}{7}$

10 A. $\frac{10}{21}$

75 B. $\frac{14}{15}$

2 C. $\frac{9}{8}$

7 D. $\frac{15}{14}$

5 E. I don't know

1.2.6 S/16. Express 0.375 as a fraction.

40 A. $\frac{3}{8}$

8 B. $\frac{5}{8}$

17 C. $\frac{375}{999}$

24 D. $\frac{37.5}{1000}$

10 E. I don't know.

1 Omit

1.2.7 S/17. Wendy bought 3 record albums on sale. The regular price was $7.24 each and the sale price was $1.50 off each record. If she paid 69¢ sales tax on her total purchase, how much money did she spend?

9 A. $17.22

67 B. $17.91

9 C. $21.72

6 D. $22.91

8 E. I don't know.

1 Omit

1.2.8 S/26. A marathon runner covers 42 kilometres in $2\frac{1}{2}$ hours. His average speed is

11 A. 8.4 km/h

66 B. 16.8 km/h

9 C. 25.2 km/h

3 D. 33.6 km/h

10 E. I don't know.

1 Omit

1.2.9 T/4. Divide: $.12\,\overline{)\,.036}$

8 A. 3

10 B. 0.003

63 C. 0.3

16 D. 0.03

2 E. I don't know.

1.2.10 T/39. Subtract: $1\frac{2}{5} - \frac{1}{2}$

4 A. $\frac{2}{3}$

66 B. $\frac{9}{10}$

13 C. $1\frac{1}{10}$

8 D. $1\frac{1}{3}$

6 E. I don't know.

4 Omit

1.2.11 T/40. Divide: $70 \div 0.001$

26 A. 0.07
7 B. 700
11 C. 7 000
44 D. 70 000
7 E. I don't know.
4 Omit

1.2.12 T/41. Write $\frac{3}{8}$ as a decimal.

5 A. 0.3
12 B. 0.24
65 C. 0.375
6 D. $2.66\overline{6}$
7 E. I don't know.
4 Omit

Objective 1.3 Ratio, Proportion & Percent

1.3.1 R/11. At a party the ratio of boys to girls was 2 to 1. What percent of the people at the party were girls?

10 A. $66\frac{2}{3}\%$

29 B. 50%

43 C. $33\frac{1}{3}\%$

9 D. 200%

9 E. I don't know.

1 Omit

1.3.2 R/12. Write $\frac{5}{6}$ as a percent.

4 A. 37.5%
2 B. $42.\overline{875142}\%$
4 C. $66.\overline{6}\%$
79 D. $83.\overline{3}\%$
11 E. I don't know.
1 Omit

1.3.3 R/39. A map of a large ranch was drawn to a scale of 2 cm to 50 m. On the map the distance from the house to one of the barns was 13 cm. What was the actual distance between the house and the barn?

13 A. 650 m
10 B. 65 m
11 C. 1300 m
48 D. 325 m
13 E. I don't know.
5 Omit

1.3.4 R/40. **The sales tax is 5%. How much would the sales tax be on a new car that costs $6750.00?**

6 A. $675.00
59 B. $337.50
9 C. $ 67.50
11 D. $ 33.75
9 E. I don't know.
6 Omit

1.3.5 R/41. Linda's new bike cost $159.99 and the sales tax was 5%. How much did she pay including tax?

11 A. $164.99
50 B. $167.99
12 C. $172.98
9 D. $177.99
12 E. I don't know.
7 Omit

1.3.6 S/27. Find 20% of 170.

5 A. 3400
6 B. 340
76 C. 34
5 D. 3.4
7 E. I don't know.
1 Omit

1.3.7 S/28. **Written as a decimal, 20% equals**

73 A. 0.2
10 B. 0.02
4 C. 2.0
11 D. 20.0
2 E. I don't know.
1 Omit

1.3.8 S/29. If there are 300 calories in 900 g of a certain food, how many calories are there in a 300 g portion of that same food?

3 A. 27
5 B. 33
81 C. 100
3 D. 270
7 E. I don't know.
1 Omit

1.3.9 S/33. If the city's property tax is $29.87 per $1000 of assessed value, the tax on a property assessed at $14,900 would be closest to which one of the following amounts?

7 A. $400
19 B. $420
43 C. $450
14 D. $470
15 E. I don't know.
2 Omit

1.3.10 S/34. Written as a percent, $\frac{5}{12}$ is

28 A. $0.41\overline{6}$%
45 B. $41.\overline{6}$%
7 C. 24.0%
7 D. 2.4%
11 E. I don't know.
2 Omit

1.3.11 T/19. John and Jean are planning a vacation trip to Winnipeg next summer. They estimate that they will drive a total of about 6500 km. Their car uses 11L/100km. Approximately how many litres of gasoline will they need for the trip?

7 A. 60
10 B. 70
18 C. 600
57 D. 700
8 E. I don't know.
1 Omit

1.3.12 T/26. Written as a percent, $\frac{1}{5}$ =

8 A. 5%
14 B. 0.5%
74 C. 20%
2 D. 50%
1 E. I don't know.
1 Omit

1.3.13 T/27. Express 0.025 as a percent.

6 A. 25%
75 B. 2.5%
14 C. 0.25%
1 D. 2.25%
2 E. I don't know.
1 Omit

1.3.14 T/28. A salesman receives 20% of the retail value of his sales as a commission. What must his total sales be to earn a commission of $60?

25 A. $1200
6 B. $ 80
50 C. $ 300
9 D. $ 240
9 E. I don't know.
1 Omit

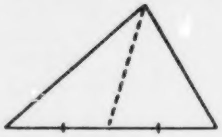
1.3.15 T/29. In a school election with three candidates, Mike received 120 votes, Lawrence received 30 votes, and Lesley received 50 votes. What percent of the total vote did Mike receive?

2 A. 30%
7 B. 40%
79 C. 60%
7 D. 120%
4 E. I don't know.
1 Omit

DOMAIN 2 Geometry

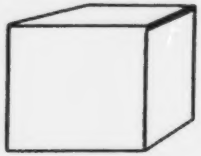
Objective 2.1 Metric Units

2.1.1 R/20. What is the name given to the dashed line in this figure?



18 A. median
20 B. altitude
38 C. angle bisector
10 D. hypotenuse
14 E. I don't know.
1 Omit

2.1.2 R/21. The heavy line shows one edge of the cube. How many edges does the cube have?

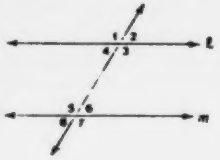


1 A. 5
7 B. 6
10 C. 9
78 D. 12
2 E. I don't know.
1 Omit

2.1.3 R/42. An ALTITUDE of a triangle always

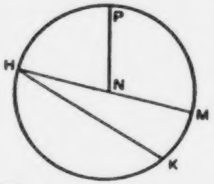
16 A. bisects an angle.
10 B. bisects a side.
23 C. is perpendicular to a side or its extension.
23 D. divides the triangle into two congruent triangles.
21 E. I don't know.
7 Omit

2.1.4 S/35. If lines ℓ and m are parallel, then a pair of corresponding angles is



11 A. ∠2 and ∠7
12 B. ∠6 and ∠3
48 C. ∠5 and ∠1
16 D. ∠5 and ∠7
10 E. I don't know.
3 Omit

2.1.5 S/48. If N is the centre, which segment is a diameter?



3 A. $\overline{HK}$

15 B. $\overline{NP}$

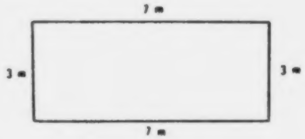
4 C. $\overline{HP}$

64 D. $\overline{HM}$

6 E. I don't know.

8 Omit

2.1.6 S/49. In the figure on the right, the length of the sides are shown. Which one of the following ensures that the figure is a rectangle?



29 A. The opposite sides are congruent.

10 B. The opposite angles are congruent.

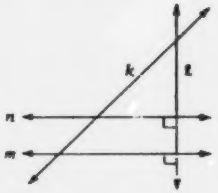
19 C. The angles are right angles.

28 D. The opposite sides are parallel.

6 E. I don't know.

8 Omit

2.1.7 T/7. Which one of the following pairs of lines is perpendicular?



29 A. m and n

4 B. k and m

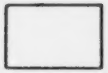
4 C. k and n

54 D. ℓ and n

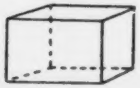
9 E. I don't know.

1 Omit

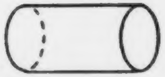
2.1.8 T/8. Shown on the right is the shape of a face obtained by cutting one of the solids below once. Which one of the following could NOT be that solid?



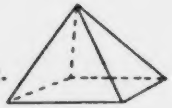
7 A.



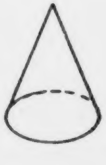
14 B.



8 C.



61 D.

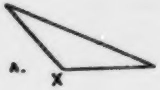


8 E. I don't know.

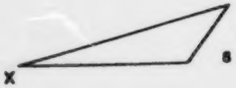
2 Omit

2.1.9 T/28. In which triangle is angle X an obtuse angle?

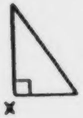
60 A.



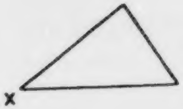
12 B.



8 C.



6 D.

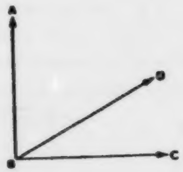


12 E. I don't know.

1 Omit

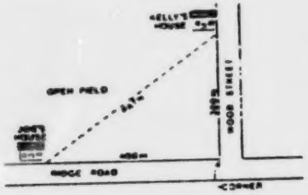
Objective 2.2 Geometric Relationships

2.2.1 R/17. ∠ABC is a right angle. The measure of ∠ABD is twice the measure of ∠CBD. What is the measure of ∠ABD?



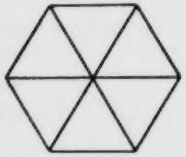
15 A. 30°
8 B. 40°
5 C. 50°
63 D. 60°
7 E. I don't know.
1 Omit

2.2.2 R/28. When Joe walks from his house to Kelly's house, he follows the path through the open field. How far does he walk?



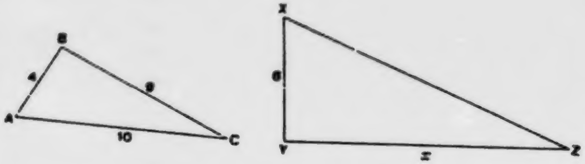
20 A. 450 m
47 B. 500 m
10 C. 550 m
11 D. 600 m
12 E. I don't know.
1 Omit

2.2.3 R/29. A regular hexagon is formed of 6 equilateral triangles. If the perimeter of each triangle is 9 cm what is the perimeter of the hexagon?



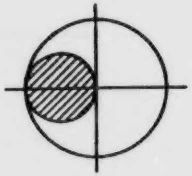
2 A. 12 cm
43 B. 18 cm
3 C. 27 cm
46 D. 54 cm
5 E. I don't know.
1 Omit

2.2.4 R/34. ΔABC is similar to ΔXYZ. Side x measures



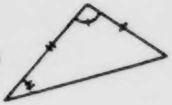
4 A. $6\frac{2}{3}$
22 B. $13\frac{1}{2}$
29 C. 15
8 D. 18
33 E. I don't know.

2.2.5 R/35. What fractional part of the large circle is shaded?

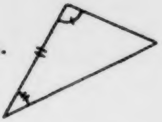


13 A. $\frac{1}{5}$
61 B. $\frac{1}{4}$
8 C. $\frac{1}{3}$
8 D. $\frac{1}{8}$
6 E. I don't know.
3 Omit

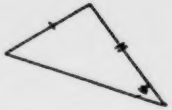
2.2.6 S/20. Which triangle is NOT necessarily congruent to the triangle shown on the right?



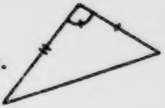
9 A.



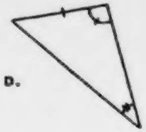
39 B.



21 C.

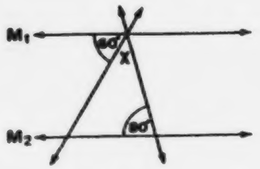


16 D.



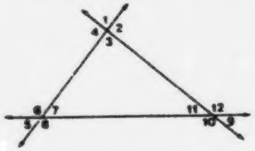
13 E. I don't know.
1 Omit

2.2.7 S/21. In the diagram M_1 is parallel to M_2. $\angle X$ =



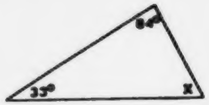
15 A. 60°
52 B. 40°
18 C. 20°
6 D. 80°
8 E. I don't know.
1 Omit

2.2.8 S/30. What is the sum of the measures of angles 1, 3, 5, 7, 9, 11?



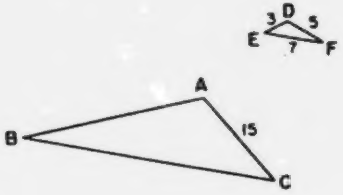
18 A. 180°
42 B. 360°
13 C. 720°
4 D. 1080°
22 E. I don't know.
2 Omit

2.2.9 S/41. What is the value of X?



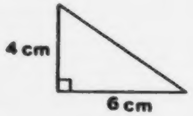
10 A. 53°
66 B. 63°
5 C. 70°
7 D. 117°
8 E. I don't know.
4 Omit

2.2.10 S/42. Triangle ABC is similar to triangle DFE. Find the length of segment BC.



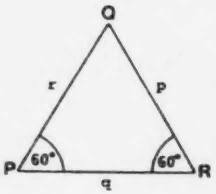
56 A. 21
5 B. 15
21 C. 35
2 D. $\frac{47}{5}$
11 E. I don't know.
5 Omit

2.2.11 T/13. If two sides of a right triangle are 6 cm and 4 cm long, find the length of the hypotenuse.



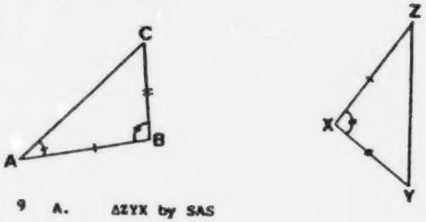
7 A. $\sqrt{20}$ cm
20 B. 10 cm
49 C. $\sqrt{52}$ cm
6 D 52 cm
17 E. I don't know.
1 Omit

2.2.12 T/14. In ΔPQR, r =



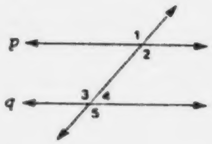
20 A. 60
46 B. p
11 C. q + p
3 D. q - p
20 E. I don't know.
1 Omit

2.2.13 T/15. ΔABC is congruent to



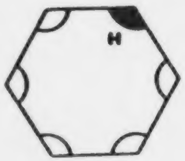
9 A. ΔZYX by SAS
10 B. ΔYXZ by ASA
39 C. ΔZXY by SAS
11 D. ΔZXY by ASA
31 E. I don't know.
1 Omit

2.2.14 T/16. If lines *p* and *q* are parallel, and ∠2 = 130°, then ∠4 =



5 A. 40°
62 B. 50°
14 C. 60°
8 D. 70°
11 E. I don't know.
1 Omit

2.2.15 T/42. The figure below is a regular hexagon. What is the measure of angle H?



36 A. 60°
7 B. 90°
40 C. 120°
4 D. 150°
10 E. I don't know.
4 Omit

DOMAIN 3 Measurement

Objective 3.1 Metric Units

3.1.1 R/18. How much would 200 g of meat cost if the price of meat is $10/kg?

49 A. $ 2
7 B. $ 5
31 C. $20
4 D. $10
9 E. I don't know.
1 Omit

3.1.2 R/22. 5 metres is the same length as

5 A. 50 centimetres
85 B. 500 centimetres
2 C. 50 millimetres
3 D. 500 millimetres
4 E. I don't know.

3.1.3 S/31. If the temperature in Vancouver on a given day is 28°C then the season is most likely

5 A. fall.
16 B. spring.
71 C. summer.
4 D. winter.
3 E. I don't know.
2 Omit

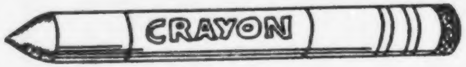
3.1.4 S/32. A ten-year-old boy is likely to weigh

3 A. 35 grams
5 B. 75 grams
70 C. 35 kilograms
12 D. 75 kilograms
8 E. I don't know.
2 Omit

3.1.5 T/21. 250 g is how many kilograms?

15 A. 25
3 B. 250
54 C. 0.25
19 D. 2.5
9 E. I don't know.
1 Omit

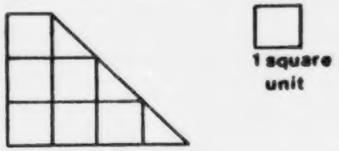
3.1.6 T/43. Approximately how long is the crayon shown below?



4 A. 10 mm
2 B. 1 cm
86 C. 10 cm
2 D. 1 m
2 E. I don't know.
4 Omit

Objective 3.2 Perimeter, Area & Volume

3.2.1 R/7. What is the area of this figure?



2 A. 6 square units
92 B. $7\frac{1}{2}$ square units
3 C. $8\frac{1}{2}$ square units
1 D. 9 square units
1 E. I don't know.

3.2.2 R/8. The perimeter of a square is 12 centimetres. Find the area in square centimetres.

14 A. 48
40 B. 9
6 C. 12
32 D. 144
8 E. I don't know.
1 Omit

3.2.3 R/9. A railway box car is 10 m long, 2 m wide and 3 m high. What is its volume in cubic metres?

6 A. 15
2 B. 20
7 C. 30
76 D. 60
9 E. I don't know.
1 Omit

3.2.4 R/19. Circle A has radius r and circle B has radius 2r. The area of circle B is

69 A. twice as large as the area of circle A.

5 B. half as large as the area of circle A.

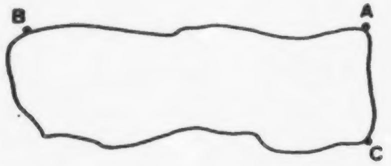
3 C. one-fourth as large as the area of circle A.

12 D. four times as large as the area of circle A.

10 E. I don't know.

1 Omit

3.2.5 R/36. Towns A, B and C are on the shore of a lake as shown in the map below. The distance from A to B is 7.8 km and the distance from A to C is 2.4 km. Which of the following is the best estimate for the area of the lake?



16 A. 10 km^2

43 B. 18 km^2

13 C. 14 km^2

13 D. 24 km^2

11 E. I don't know.

4 Omit

3.2.6 S/4. The perimeter of an isosceles triangle is 21 cm and the length of one of its equal sides is 9 cm. What is the length of its shortest side?

11 A. 6 cm

4 B. 1.5 cm

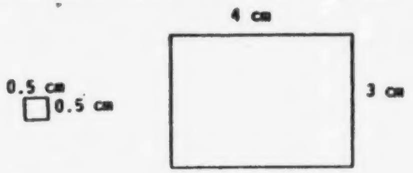
5 C. 4.5 cm

70 D. 3 cm

9 E. I don't know.

1 Omit

3.2.7 S/5. How many of the squares will fit into the rectangle?



2 A. 6

10 B. 12

27 C. 24

57 D. 48

3 E. I don't know.

3.2.8 S/6. A litre of asphalt paint will cover about 6 m^2 of surface. The paint is sold in cans of 5 litres only. How many cans are needed to paint a driveway 15 m long and 3 m wide?

38 A. 2

16 B. 7

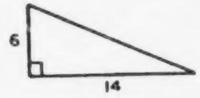
19 C. 8

14 D. 9

13 E. I don't know.

1 Omit

3.2.9 S/24. Find the area of this right triangle.



46 A. 42

10 B. 20

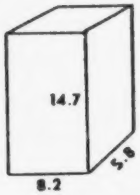
26 C. 84

5 D. 21

12 E. I don't know.

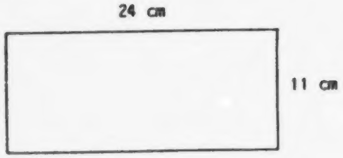
1 Omit

3.2.10 S/25. The best estimate for the volume of the solid shown below is



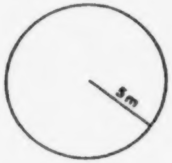
10 A. 29
10 B. 56
25 C. 550
39 D. 720
15 E. I don't know.
1 Omit

3.2.11 T/5. The perimeter of the rectangle is



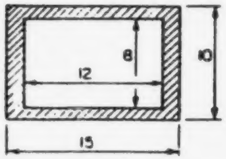
6 A. 35 cm
70 B. 70 cm
20 C. 264 cm
2 D. 697 cm
2 E. I don't know.

3.2.12 T/6. The best estimate for the area of the circle shown below is



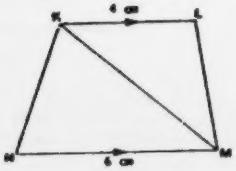
18 A. 15 m^2
34 B. 75 m^2
7 C. 100 m^2
23 D. 5 m^2
17 E. I don't know.
1 Omit

3.2.13 T/22. What is the area of the shaded portion of this figure?



51 A. 54
15 B. 96
7 C. 120
8 D. 60
19 E. I don't know.
1 Omit

3.2.14 T/23. The area of triangle KLM = 8 cm^2.
The area of trapezoid KLMN is



7 A. 10 cm^2
15 B. 16 cm^2
30 C. 20 cm^2
21 D. 24 cm^2
26 E. I don't know.
1 Omit

3.2.15 T/44. A small cube measures 2 cm by 2 cm by 2 cm. How many of these can be put into a rectangular box that is 24 cm long, 10 cm wide and 6 cm deep?

19 A. 60
45 B. 180
10 C. 720
6 D. 1440
15 E. I don't know.
5 Omit

DOMAIN 4 Algebraic Topics

Objective 4.1 Expressions, Equations & Inequalities

4.1.1 R/37. If $x = 4$, $y = 2$, and $z = 0.5$, the value of $2xy^2z$ is

61 A. 16
9 B. 32
7 C. 64
8 D. 128
10 E. I don't know.
4 Omit

4.1.2 R/38. Find the roots of the equation $(x - 1)(x + 7) = 0$

46 A. 1, -7
6 B. 1, 7
7 C. -1, -7
17 D. -1, 7
18 E. I don't know.
5 Omit

> The formula to calculate simple interest is $i = Prt$ where i is the interest, P is the principal, r is the rate, and t is the time in years.

4.1.3 R/45. Using the formula shown above, find the interest on a principal of $1000 invested for two years at an annual rate of 7%.

41 A. $ 140
16 B. $1400
11 C. $ 70
6 D. $ 14
15 E. I don't know.
11 Omit

4.1.4 R/46. Using the formula shown above, find the principal, if the interest received after two years at an annual rate of 6% is \$60.

8 A. \$2000
8 B. \$5000
31 C. \$ 500
17 D. \$ 720
25 E. I don't know.
12 Omit

4.1.5 R/47. The equation $2(x + 7) = 2(x + 3) + 8$ is true for

27 A. all values of x.
15 B. no values of x.
13 C. only values of x greater than 7.
10 D. only values of x less than 7.
23 E. I don't know.
12 Omit

4.1.6 R/48. If $\frac{2x - 1}{3} = \frac{2x + 1}{5}$, then $x =$

9 A. $\frac{1}{2}$
11 B. $-\frac{1}{2}$
38 C. 2
9 D. -2
21 E. I don't know.
13 Omit

4.1.7 R/49. Which expression represents a number that is 9 more than two-thirds of a given number?

46 A. $\frac{2}{3}x + 9$
8 B. $\frac{3}{2}x + 9$
16 C. $\frac{2}{3}(x + 9)$
5 D. $\frac{3}{2}(x + 9)$
12 E. I don't know.
13 Omit

4.1.8 S/37. If $y = \frac{5}{x}$, what happens to y as x increases?

19 A. y increases
44 B. y decreases
14 C. y remains the same
12 D. cannot tell what happens to y
8 E. I don't know.
3 Omit

4.1.9 S/38. Evaluate $-4a(a - 3b)$ when $a = 2$ and $b = -1$

50 A. -40
12 B. -8
15 C. 8
7 D. 40
13 E. I don't know.
4 Omit

4.1.10 S/39. Simplify: $\frac{24x^3y^2}{-6x}$

60 A. $-4x^2y^2$
13 B. $4x^2y^2$
8 C. $-4x^3y$
5 D. -4^3y^2
10 E. I don't know.
4 Omit

4.1.11 S/40. Last summer a boy worked w weeks at d dollars per week. His expenditures for the summer were k dollars. His savings (in dollars) were

6 A. $wk - d$
66 B. $wd - k$
8 C. $w + k + d$
6 D. $w + k - d$
9 E. I don't know.
4 Omit

4.1.12 S/45. $r + s - (r - s) =$

30 A. 0
16 B. $2r + 2s$
7 C. $2r$
25 D. $2s$
16 E. I don't know.
7 Omit

4.1.13 S/46. If $12 + 7x = 11 - 2x$, then $x =$

9 A. -1
8 B. $\frac{23}{9}$
14 C. $-\frac{1}{5}$
33 D. $-\frac{1}{9}$
28 E. I don't know.
8 Omit

4.1.14 S/47. In factored form, $x^2 - 7x + 12 =$

5 A. $(x + 4)(x + 3)$
12 B. $(x - 4)(x + 3)$
9 C. $(x + 4)(x - 3)$
54 D. $(x - 4)(x - 3)$
13 E. I don't know.
8 Omit

4.1.15 T/17. Which rule fits this table?

a	b
1	6
2	8
3	10
4	12

9 A. $b = 3a + 3$
4 B. $b = 2a + 3$
6 C. $b = 3a + 2$
66 D. $b = 2a + 4$
15 E. I don't know.
1 Omit

4.1.16 T/30. Solve for x and y: $x + 2y = 6$, $2x - y = 2$

12 A. $x = 4 \quad y = 1$
6 B. $x = 2 \quad y = \frac{10}{3}$
59 C. $x = 2 \quad y = 2$
5 D. $x = \frac{8}{5} \quad y = \frac{4}{5}$
16 E. I don't know.
2 Omit

4.1.17 T/31. If $y = 15 - x$, what happens to y as x increases?

11 A. y increases
64 B. y decreases
10 C. y remains the same
7 D. cannot tell what happens to y
6 E. I don't know.
2 Omit

4.1.18 T/32. The cost of a new car is less than 4 times the cost of a used car. If x represents the cost of a new car, and y represents the cost of a used car, which one of these is true?

56 A. $x < 4y$
6 B. $x - y = 4$
16 C. $y > 4x$
9 D. $x = y + 4$
11 E. I don't know.
2 Omit

4.1.19 T/36. When $m = -1$ and $n = 1$, the value of $\frac{m^{20}}{n}$ is

14 A. -1
34 B. 1
28 C. -20
10 D. 20
12 E. I don't know.
3 Omit

4.1.20 T/37. If $6 + 5n = 41$, then $n =$

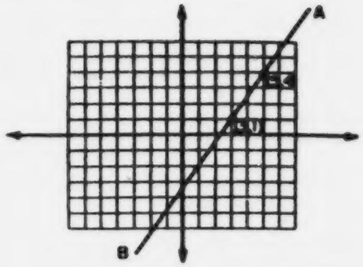
5 A. 6
4 B. $\frac{47}{5}$
5 C. $\frac{41}{11}$
76 D. 7
8 E. I don't know.
3 Omit

4.1.21 T/38. If $4(x - 3) - x = 5(x + 8) + 12$, then $x =$

30 A. -32
13 B. -16
18 C. 16
9 D. 32
27 E. I don't know.
4 Omit

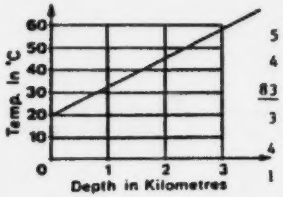
Objective 4.2 Graphs

4.2.1 R/15. The slope of line AB is



39 A. $\frac{3}{2}$
8 B. $-\frac{3}{2}$
22 C. $\frac{2}{3}$
7 D. $-\frac{2}{3}$
23 E. I don't know.
1 Omit

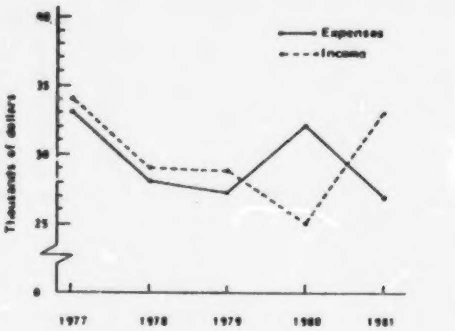
4.2.2 R/16. From the graph below, the temperature at a depth of 2.5 km is closest to



5 A. 30°C
4 B. 40°C
83 C. 50°C
3 D. 60°C
4 E. I don't know.
1 Omit

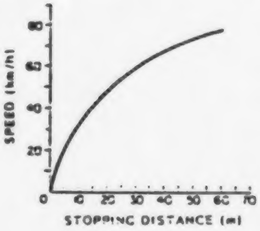
4.2.3 R/23. According to the graph below, in which year did the Metro Company make the largest dollar amount of profit?

Income and Expenses of Metro Co. 1977 - 1981



3 A. 1978
4 B. 1979
12 C. 1980
77 D. 1981
3 E. I don't know.
1 Omit

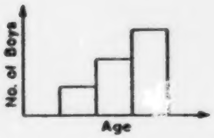
4.2.4 S/10. This graph represents the relationship between the speed of a car in kilometres per hour (km/h) and the stopping distance in metres (m) after first applying the brakes. If the skid marks were 45 metres long, about how fast was the car travelling when the brakes were first applied?



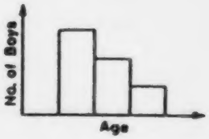
5 A. 40 km/h
9 B. 56 km/h
70 C. 72 km/h
5 D. 88 km/h
10 E. I don't know.
1 Omit

4.2.5 S/18. Here are the ages of six boys: 10, 9, 9, 8, 8, 8.
Which of the following bar graphs represents this information?

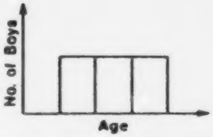
23 A.



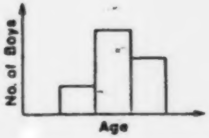
61 B.



4 C.



2 D.

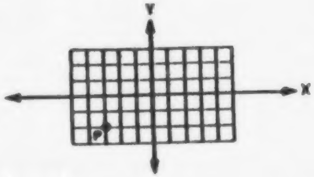


8 E. I don't know.
1 Omit

4.2.6 S/19. In a coordinate plane a rectangle has vertices at the points (-2, 3), (-2, -2), (12, -2) and (12, 3). What is the area of this rectangle?

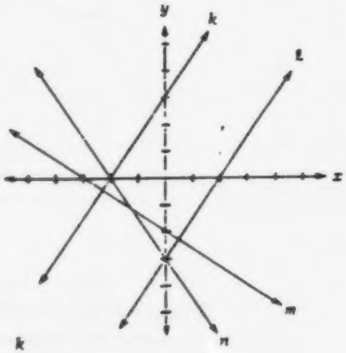
9 A. 38
6 B. 50
30 C. 70
8 D. 84
45 E. I don't know.
1 Omit

4.2.7 T/18. The coordinates of point P are



4 A. (3, 2)
10 B. (-2, -3)
3 C. (2, 3)
78 D. (-3, -2)
5 E. I don't know.
1 Omit

4.2.8 T/24. Which line is the graph of the equation $y = \frac{3}{2}x - 3$?

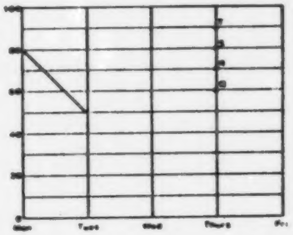


13 A. k
35 B. ℓ
14 C. m
10 D. n
27 E. I don't know.
1 Omit

4.2.9 T/47. Here is a table that shows the number of trees planted along a highway in a week.

Day of the Week	Mon.	Tues.	Wed.	Thurs.	Fri.
Number of Trees Planted	80	50	60	90	75

On the diagram below, the graph for the first two days' planting has been drawn. If the graph were completed, which of these points would the line pass through?



4 A. Q
7 B. R
8 C. S
68 D. T
6 E. I don't know.
7 Omit

DOMAIN 5 Probability & Statistics

Objective 5.1 Probability

5.1.1 R/24. Suppose you are playing a game. If you toss a coin and it lands tails you win \$3, but if it lands heads you lose \$2.

If you toss the coin just one time you will

3 A. probably win money.
86 B. be equally likely to win or lose money.
3 C. probably lose money.
4 D. probably win one dollar.
3 E. I don't know.
1 Omit

5.1.2 R/50. The roof and the body of a car are to be painted different colours. Using only 5 colours, how many different ways can the car be painted?

17 A. 5
6 B. 9
27 C. 10
28 D. 20
10 E. I don't know.
13 Omit

5.1.3 S/7. If the probability that it will rain on a given day is 0.36, then the probability that it will NOT rain is

56 A. 0.64
6 B. 0.36
32 C. 99.64
2 D. 99.36
6 E. I don't know.
1 Omit

5.1.4 S/11. If, on the roll of a die, the probability that a five will appear is $\frac{1}{6}$, then the probability that a five or a three will appear is

17 A. $\frac{1}{6}$
5 B. $\frac{1}{36}$
59 C. $\frac{1}{3}$
11 D. $\frac{1}{12}$
7 E. I don't know.

5.1.5 T/9. For a party game each number shown below was painted on a different Ping Pong ball, and the balls were thoroughly mixed up in a bowl. If a ball is picked from the bowl by a blindfolded person, what is the probability that the ball will have a 4 on it?

2,.3, 4, 4, 5, 6, 8, 8, 9, 10

3 A. $\frac{1}{2}$
10 B. $\frac{1}{4}$
59 C. $\frac{1}{5}$
21 D. $\frac{1}{10}$
5 E. I don't know.
1 Omit

5.1.6 T/25. Mike flips two quarters. What is the probability that they both land heads?

36 A. $\frac{1}{4}$
5 B. $\frac{1}{3}$
52 C. $\frac{1}{2}$
3 D. $\frac{2}{3}$
3 E. I don't know.
1 Omit

Objective 5.2 Statistics

5.2.1 R/4. The median of the set of numbers

{ 2, 2, 2, 3, 4, 5, 10 } is

17 A. 4
25 B. 2
24 C. 3
4 D. 10
28 E. I don't know.
1 Omit

AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers Per Month Jan.	 Feb.	 Mar.	 Apr.	 May	 Jun.	Total
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

5.2.2 R/32. How many more passengers used the airports in January than in April?

53 A. 4
2 B. 2900
2 C. 29
38 D. 400
2 E. I don't know.
2 Omit

5.2.3 R/33. How many passengers used the Fiske Airport in June?

48 A. 7
8 B. 26
33 C. 700
6 D. 2600
2 E. I don't know.
3 Omit

5.2.4 S/8. The mean of the set of numbers

{ 2, 2, 2, 3, 4, 5, 10 } is

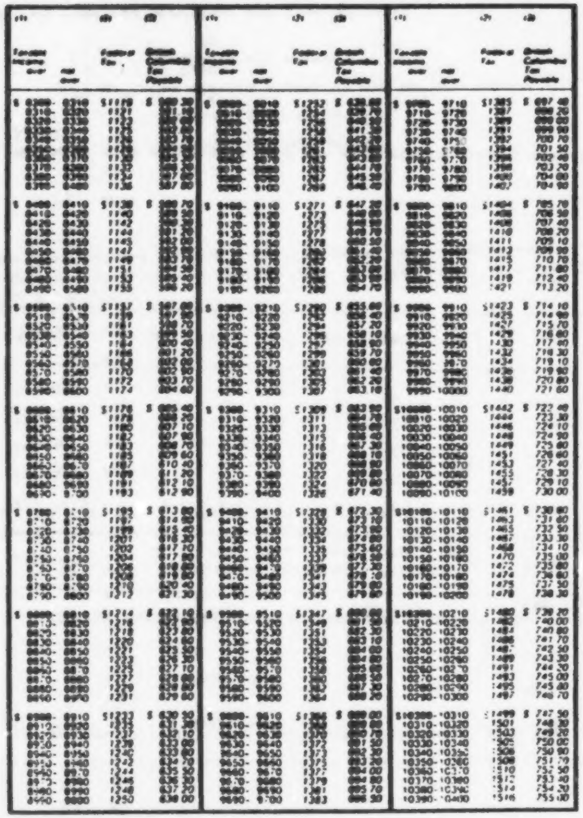
10 A. 3
30 B. 2
8 C. 10
21 D. 4
31 E. I don't know.

5.2.5 S/9. The mode of the set of numbers

{ 2, 2, 2, 3, 4, 5, 10 } is

27 A. 2
11 B. 3
8 C. 4
13 D. 10
40 E. I don't know.
1 Omit

5.2.6 S/36. Using the tax table shown below, find the total tax payable (federal and provincial) on a taxable income of $10,358.62.



29 A. $ 751.70

11 B. $1508.00

42 C. $2259.70

4 D. $2256.90

10 E. I don't know.

4 Omit

5.2.7 T/10. The table below shows, for each of four age groups, the number of injuries to pedestrians and the total number of injuries related to motor vehicles which occurred during 1980.

Age Group	Pedestrian Injuries	Total Number of Injuries
15–24	25 000	700 000
25–44	20 000	600 000
45–64	20 000	350 000
65–74	8 000	70 000

Which age group had the lowest ratio of pedestrian injuries to total injuries?

18 A. 15–24

15 B. 25–44

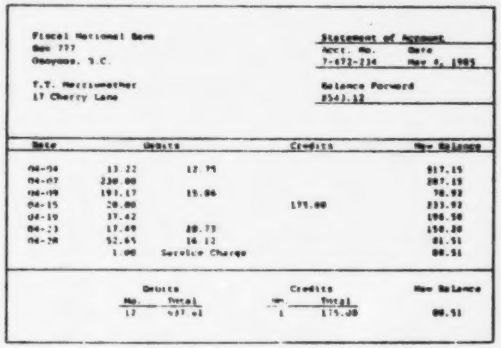
9 C. 45–64

53 D. 65–74

5 E. I don't know.

1 Omit

5.2.8 T/45. How much money does T.T. Merriweather have in his account now?



Fiscal National Bank
Box 777
Osoyoos, B.C.

T.T. Merriweather
17 Cherry Lane

Statement of Account

Acct. No.	Date
7-472-234	May 6, 1985

Balance Forward
$543.12

Date	Debits		Credits	New Balance
04-04	13.22	12.75		517.15
04-07	230.00			287.15
04-09	193.17	15.06		78.92
04-15	20.00		175.00	233.92
04-19	37.42			196.50
04-23	17.49	28.73		150.28
04-28	52.65	16.12		81.51
	1.00	Service Charge		80.51

Debits No.	Debits Total	Credits No.	Credits Total	New Balance
12	637.61	1	175.00	80.51

82 A. $ 80.51

2 B. $175.00

6 C. $543.12

2 D. $636.61

2 E. I don't know.

5 Omit

5.2.9 T/48. The sets of numbers { 8, 12, 14, 15, 19 } and { 10, 11, 14, 18, 21 } have the same __________, although their __________ are different.

9 A. mean; modes
12 B. mean; medians
16 C. median; means
21 D. median; ranges
36 E. I don't know.
7 Omit

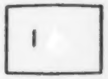
DOMAIN 6 Computers & Calculators

Objective 6.1 Computer Literacy

6.1.1 R/30. An imaginary computer can draw pictures on a television screen.

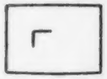
When given the instruction MOVE

it will draw a picture like this



When given the instruction MOVE R MOVE

it will draw this picture



Which one of the following sets of instructions would draw a square?

2 A. R R R R
9 B. MOVE R R R
4 C. MOVE MOVE MOVE MOVE
74 D. MOVE R MOVE R MOVE R MOVE
10 E. I don't know.
2 Omit

6.1.2 R/31. An imaginary computer has commands called PRAX and ADDO

PRAX does the following: Print out the value of X
Do the command called ADDO

ADDO does the following: Add 2 to the current value of X
Do the command called PRAX

What will the following set of instructions do?

```
X = 2
PRAX
```

2 A. print out the odd numbers greater than 0
16 B. print out all integers greater than 2
31 C. print out the even numbers greater than 0
6 D. print out all integers less than 2
42 E. I don't know.
2 Omit

6.1.3 S/12. What is the numerical value of the computer language expression shown in the box below?

$$\boxed{2 \uparrow 3 - 2 * 3}$$

15 A. 0
16 B. 2
14 C. 12
6 D. 18
48 E. I don't know.
1 Omit

6.1.4 S/44. A set of instructions for an imaginary computer is as follows:

1. Arrange the three names Sandy, Dale, and Pat in alphabetical order
2. Remove the last name from the list
3. If only one name is left, stop, otherwise go on to step 4
4. Print out the names in reverse order
5. Go back to step 2

What will the computer print?

55 A. Pat
8 B. Dale, Pat
8 C. Dale, Pat, Sandy
15 D. Pat, Dale
9 E. I don't know.
6 Omit

6.1.5 T/11. Which one of the following computer language expressions is equal to the arithmetic expression shown in the box below?

$$\boxed{\frac{2^3 - 3 \times 4}{2 + 7}}$$

5 A. 2*3 - 3↑4/2+7
29 B. (2↑3 - 3*4)/(2+7)
24 C. 2↑3 - 3*4/2+7
4 D. 2*3 - 3↑4/(2+7)
38 E. I don't know.
1 Omit

6.1.6 T/35. A list of instructions for a computer is called a

78 A. program.
5 B. disk.
5 C. terminal.
4 D. memory.
7 E. I don't know.
2 Omit

Objective 6.2 Calculator Use

6.2.1 R/6. You wish to calculate 5 times -6 on the calculator. Which one of the following sequences of keystrokes will likely give the correct answer?

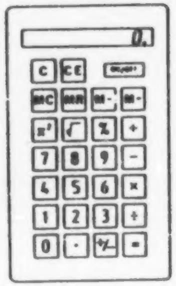
8 A. $\boxed{5}\boxed{\times}\boxed{6}\boxed{-}\boxed{=}$

26 B. $\boxed{5}\boxed{\times}\boxed{-}\boxed{6}\boxed{=}$

15 C. $\boxed{5}\boxed{\times}\boxed{M-}\boxed{6}\boxed{=}$

45 D. $\boxed{5}\boxed{\times}\boxed{6}\boxed{+/-}\boxed{=}$

5 E. I don't know.



6.2.2 R/13. Which one of the following keys would you push to get back the answer to a calculation which you had stored in the calculator?

9 A. $\boxed{M+}$

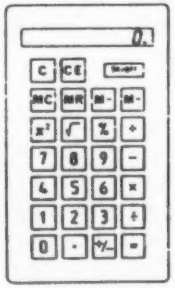
2 B. $\boxed{M-}$

1 C. $\boxed{+/-}$

81 D. $\boxed{MR}$

6 E. I don't know.

1 Omit



6.2.3 R/14. The following sequence of keystrokes is carried out on the calculator:

$\boxed{2}\boxed{6}\boxed{M+}\boxed{1}\boxed{0}\boxed{M-}\boxed{MR}\boxed{\sqrt{\ }}$

What will likely be shown in the display?

23 A. $\boxed{4.}$

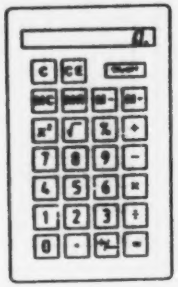
19 B. $\boxed{6.}$

5 C. $\boxed{256.}$

15 D. $\boxed{3.1622777}$

37 E. I don't know.

1 Omit



6.2.4 S/22. You wish to calculate the square root of 64 on the calculator. Which one of the following sequences of keystrokes will likely give the correct answer?

13 A. $\boxed{\sqrt{\ }}\boxed{6}\boxed{4}$

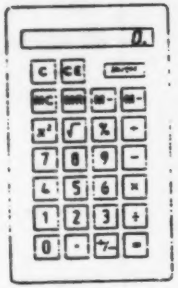
77 B. $\boxed{6}\boxed{4}\boxed{\sqrt{\ }}$

3 C. $\boxed{6}\boxed{4}\boxed{\times}\boxed{6}\boxed{4}\boxed{=}$

3 D. $\boxed{6}\boxed{4}\boxed{x^2}$

3 E. I don't know.

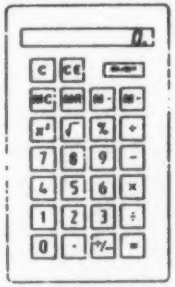
1 Omit



6.2.5 8/23. The following sequence of keystrokes is carried out on the calculator:

6 3 + 7 CE 6 =

What will likely be shown in the display?



47 A. 6.

25 B. 69.

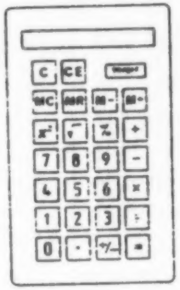
10 C. 76.

3 D. 636.

14 E. I don't know.

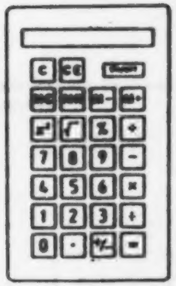
1 Omit

6.2.6 5/43. Think of a calculator as a person. A person's ears and eyes are like the calculator's



12 A. chip.
47 B. keys.
5 C. battery.
22 D. memory.
8 E. I don't know.
5 Omit

6.2.7 T/33. Which one of the following keys would you push to store the answer to a calculation so you could use it later on?



58 A. M+

31 B. MR

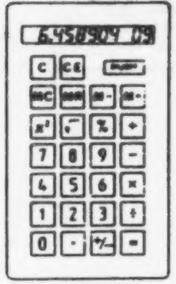
3 C. CE

1 D. +

5 E. I don't know.

2 Omit

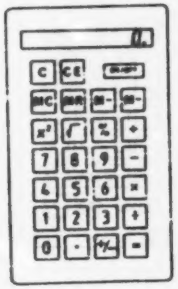
6.2.8 T/34. Someone has just multiplied 6540 by 987 600 on the hand calculator. The calculator with the answer displayed is shown on the right.



The product of the two numbers is

17 A. 6 458 904 000
15 B 6 458 904 009
41 C. 6.458904^{9}
5 D. 645 890 400
19 E. I don't know.
2 Omit

6.2.9 T/46. You wish to calculate 6% of 85 on the calculator. Which one of the following sequences of keystrokes will likely give the correct answer?



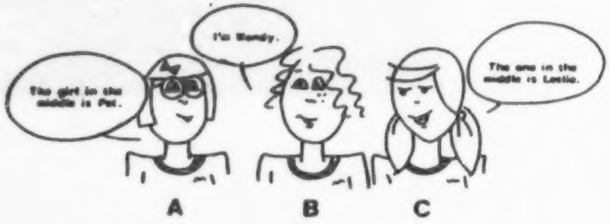
27 A. 6 % × 8 5 =
11 B. 6 % 8 5
22 C. 8 5 ÷ 6 % =
28 D. 8 5 × 6 %
5 E. I don't know.
6 Omit

DOMAIN 7 Problem Solving

7.1.1 8/5. The numbers 111, 21, 12, and 3 are all the whole numbers whose digits have a sum of 3. Zero is not used. How many numbers are there that have digits that add up to 5?

25 A. 6
13 B. 8
18 C. 15
11 D. 16
32 E. I don't know.
1 Omit

7.1.2 8/43. Three tennis players named Pat, Wendy and Leslie are walking to the courts. Pat, the best player of the three, always tells the truth. Wendy sometimes tells the truth, while Leslie never tells the truth. Who is Pat?


The girl in the middle is Pat.
I'm Wendy.
The one in the middle is Leslie.
A
B
C

9 A. A
12 B. B
46 C. C
15 D. either A or B
10 E. I don't know.
9 Omit

7.1.3 8/44. I am a number between 25 and 40. I have a remainder of two when divided by both 6 and 9. Who am I?

7 A. 26
8 B. 29
13 C. 32
48 D. 38
15 E. I don't know.
10 Omit

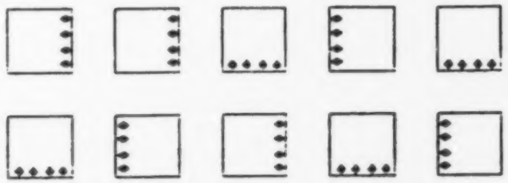
7.1.4 S/13. A 4 x 4 x 4 cube is painted blue and is then cut into 64 unit cubes. The number of cubes with paint on exactly one face is

11 A. 4
9 B. 8
34 C. 16
28 D. 24
17 E. I don't know.

7.1.5 S/14. Tracy bought a car for $100, sold it for $200, repurchased it for $300, then resold it for $400. Tracy

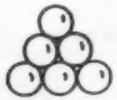
61 A. made $200.
27 B. broke even.
7 C. lost $100.
3 D. lost $200.
2 E. I don't know.
1 Omit

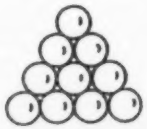
7.1.6 S/50. What is the minimum number of tiles that must be turned so that they are all facing the same way?



17 A. 4
7 B. 5
56 C. 6
4 D. 11
7 E. I don't know.
8 Omit

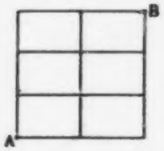
7.1.7 T/12. Marbles are arranged in the shape of a triangle on the floor. How many marbles are there in a triangle with 7 marbles in the base?





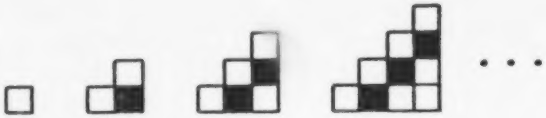
6 A. 12
74 B. 28
4 C. 42
5 D. 49
9 E. I don't know.

7.1.8 T/49. How many different routes are there from A to B? You may travel only up and to the right.



33 A. 8
25 B. 10
11 C. 15
16 D. 18
7 E. I don't know.
7 Omit

7.1.9 T/50. How many white squares will there be in the 10th figure in the following pattern?

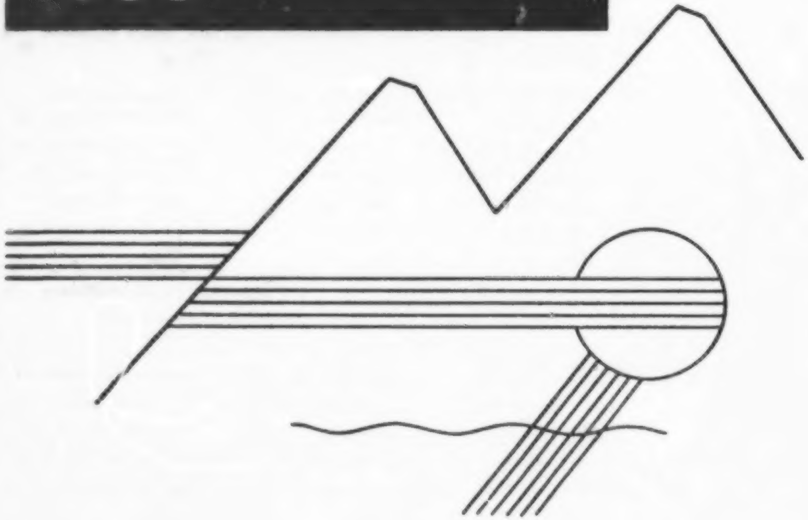


18 A. 45
26 B. 46
20 C. 55
7 D. 512
21 E. I don't know.
8 Omit

GRADE 4
TEACHER'S GUIDE
QUESTIONNAIRE

BRITISH COLUMBIA

MATHEMATICS
ASSESSMENT
1985



SCALE R: MATHEMATICS IN SCHOOL

Please record your responses ON THE ANSWER SHEET
in the section labelled "FORM R".

For each of the items in this scale, three responses are required. Consider only the class designated by your principal for this questionnaire.

A. Tell how important you think the topic is for this class.
B. Tell how easy it is to teach the topic to this class.
C. Tell how much you like teaching the topic to this class.

1. Adding, subtracting, multiplying and dividing whole numbers

A.		B.		C.	
0.1	not at all important	0.5	very difficult	0.0	dislike a lot
0.2	not important	21.7	difficult	1.0	dislike
0.1	undecided	13.[illegible]	undecided	3.6	undecided
12.2	important	54.5	easy	57.8	like
87.5	very important	10.0	very easy	37.7	like a lot

2. Learning about decimals

A.		B.		C.	
2.9	not at all important	4.1	very difficult	0.4	dislike a lot
11.1	not important	24.5	difficult	2.9	dislike
12.4	undecided	26.3	undecided	25.8	undecided
42.9	important	39.5	easy	55.3	like
30.7	very important	5.7	very easy	15.5	like a lot

3. Learning about fractions

A.		B.		C.	
1.0	not at all important	5.0	very difficult	0.7	dislike a lot
10.7	not important	29.8	difficult	4.1	dislike
13.0	undecided	15.7	undecided	14.8	undecided
57.9	important	43.0	easy	58.1	like
17.4	very important	6.5	very easy	22.2	like a lot

4. Learning the metric system

A.	B.	C.
0.0 not at all important	1.4 very difficult	1.1 dislike a lot
0.9 not important	24.9 difficult	6.9 dislike
6.7 undecided	19.5 undecided	17.6 undecided
42.0 important	46.4 easy	57.4 like
50.4 very important	7.9 very easy	17.0 like a lot

5. Learning how to estimate

A.	B.	C.
0.4 not at all important	3.7 very difficult	0.7 dislike a lot
4.3 not important	32.5 difficult	7.1 dislike
9.6 undecided	18.5 undecided	22.9 undecided
57.7 important	40.1 easy	56.3 like
28.0 very important	5.2 very easy	13.0 like a lot

6. Learning about squares, rectangles, and triangles

A.	B.	C.
0.2 not at all important	0.2 very difficult	0.2 dislike a lot
6.4 not important	6.0 difficult	1.6 dislike
16.0 undecided	12.4 undecided	12.0 undecided
64.8 important	61.2 easy	62.7 like
12.5 very important	20.1 very easy	23.5 like a lot

7. Checking answers by going back over them

A.	B.	C.
0.2 not at all important	10.3 very difficult	2.1 dislike a lot
0.9 not important	37.4 difficult	13.4 dislike
5.2 undecided	15.4 undecided	30.2 undecided
37.8 important	29.8 easy	42.7 like
56.0 very important	7.2 very easy	11.5 like a lot

8. Using graphs

A.	B.	C.
0.0 not at all important	0.4 very difficult	0.0 dislike a lot
3.3 not important	12.1 difficult	1.8 dislike
10.4 undecided	13.2 undecided	10.3 undecided
64.3 important	59.7 easy	56.8 like
22.0 very important	14.6 very easy	31.1 like a lot

9. Solving word problems

A.	B.	C.
0.1 not at all important	16.5 very difficult	1.4 dislike a lot
0.2 not important	48.2 difficult	6.7 dislike
1.6 undecided	13.8 undecided	15.7 undecided
34.1 important	18.6 easy	55.1 like
64.0 very important	2.9 very easy	21.1 like a lot

10. Learning about place value

A.	B.	C.
0.1 not at all important	5.8 very difficult	0.5 dislike a lot
0.5 not important	30.2 difficult	4.7 dislike
2.3 undecided	15.4 undecided	12.7 undecided
26.6 important	40.3 easy	61.3 like
70.5 very important	8.3 very easy	20.8 like a lot

SCALE S: PROBLEM SOLVING

Please record your responses ON THE ANSWER SHEET
in the section labelled "FORM S".

For Items 1-7, mark the response which best describes your opinion about each statement with respect to the class designated by your principal for this questionnaire.

1. Most of my students enjoy problem solving.

4.9 A. Strongly Disagree
37.4 B. Disagree
21.4 C. Undecided
33.9 D. Agree
2.4 E. Strongly Agree

2. Most of my students perform well in problem solving.

3.9 A. Strongly Disagree
39.8 B. Disagree
23.4 C. Undecided
31.4 D. Agree
1.5 E. Strongly Agree

3. The textbooks I use provide adequate instruction for developing problem-solving skills.

27.0 A. Strongly Disagree
39.8 B. Disagree
9.8 C. Undecided
21.3 D. Agree
2.2 E. Strongly Agree

4. My district provides adequate assistance and resources for the teaching of problem solving.

7.2 A. Strongly Disagree
22.3 B. Disagree
31.8 C. Undecided
34.3 D. Agree
4.4 E. Strongly Agree

5. I am satisfied with my teaching of problem solving.

2.3 A. Strongly Disagree
21.3 B. Disagree
29.6 C. Undecided
42.3 D. Agree
4.5 E. Strongly Agree

6. All mathematics teachers should attend at least one workshop on problem solving each year.

5.2 A. Strongly Disagree
23.5 B. Disagree
25.1 C. Undecided
35.2 D. Agree
11.0 E. Strongly Agree

7. It is easy to teach problem solving.

9.6 A. Strongly Disagree
50.6 B. Disagree
19.2 C. Undecided
18.4 D. Agree
2.2 E. Strongly Agree

8. Which of these problem-solving strategies do you teach in your classes? (Mark all that apply.)

84.7 A. Look for a pattern
37.5 B. Guess and check
62.9 C. Make a systematic list or table
63.0 D. Solve a simpler problem
37.9 E. Work backwards

9. How many workshops on problem solving have you attended in the past year?

73.0 A. None
21.4 B. 1
4.0 C. 2
1.0 D. 3
0.6 E. More than 3

10. What sources do you use to provide students with problem-solving exercises? (Mark all that apply.)

94.6 A. Textbook
24.7 B. Mathematical contests
72.2 C. Problem-solving booklets
18.5 D. Professional journals
63.6 E. Books of puzzles

11. Which of the following do you use to motivate your students to participate in problem-solving activities? (Mark all that apply.)

45.3 A. Competitive games
39.5 B. Problem of the day or week
82.9 C. Puzzles or brain teasers
33.2 D. Library or file of interesting problems
29.0 E. Contests

12. Which of the following best characterizes your teaching of problem solving in mathematics? I teach problem solving:

21.4 A. As a unit from time to time
34.6 B. Almost every day, as a regular part of the mathematics class
11.1 C. One period every 2 or 3 weeks
15.4 D. At the end of a major topic or chapter
17.5 E. One period a week

13. When you grade students' work in problem solving, for which of the following do you give marks? (Mark all that apply.)

5.9 A. I don't give partial credit. It's all or nothing.
71.4 B. For the appropriate diagram or equation
86.3 C. For the procedures used (computation, etc.)
85.5 D. For the final answer
25.1 E. For checking the answer

14. Which of the following types of problems do you assign to your students? (Mark all that apply.)

33.4 A. Problems with more than one correct answer
66.8 B. Problems which require students to collect information
80.0 C. Problems which can be solved more than one way
39.8 D. Problems which students work on collectively in groups
44.9 E. Problems with either too much or too little information

15. Which of the following activities do you have in your class? (Mark all that apply.)

19.6 A. A problem-solving center
13.5 B. A bulletin board display on problem solving
33.5 C. Problem of the week
45.5 D. Problem-solving contests within the class
64.4 E. Students make up problems for others to solve

SCALE T: CALCULATORS AND COMPUTERS

Please record your responses ON THE ANSWER SHEET in the section labelled "FORM T".

When responding, consider only the designated class.

1. Do you own a calculator?

91.1 A. Yes
8.9 B. No

2. How often do you use a calculator outside school?

4.7 A. Never
41.7 B. Rarely (perhaps less than once a week)
39.0 C. Sometimes (a couple of times a week)
14.6 D. Frequently (almost every day)

3. In what ways do you have your students use calculators in mathematics? (Mark all that apply.)

81.9 A. Not at all
11.8 B. For drill and practice to enhance computational skills
8.1 C. To work on problems
8.9 D. For other topics such as estimating, finding patterns, and so on

4. How are students in your class provided with calculators?

56.9 A. I do not allow calculators in my class.
33.9 B. Each student may bring his or her own.
1.0 C. Each student must bring his or her own.
8.2 D. Calculators are provided for the students.

5. In what ways do you use a calculator for non-instructional school work? (Mark all that apply.)

18.1 A. None
77.5 B. To calculate students' marks, grades, and so on
40.5 C. To check students' answers on assignments
33.7 D. To prepare worksheets or tests

6. Some people say that Grade 4 students should not be allowed to use calculators in school. How do you feel about this?

10.1 A. Strongly Disagree
25.3 B. Disagree
24.9 C. Undecided
25.4 D. Agree
14.2 E. Strongly Agree

7. Some people say that if students are allowed to use calculators, then it is not necessary for them to learn how to add, subtract, multiply, or divide by hand. How do you feel about this?

63.0 A. Strongly Disagree
18.6 B. Disagree
5.9 C. Undecided
8.0 D. Agree
4.5 E. Strongly Agree

8. Do you have a computer (one that will do more than play games) at home?

20.6 A. Yes
78.6 B. No

9. What applications of computers have you had experience with? (Mark all that apply.)

8.1 A. None
75.3 B. Games
48.6 C. Word processing
70.7 D. Computer-assisted instruction
36.3 E. Programming

10. Where did you get most of your experience with computers?

10.9 A. I haven't had any experience with computers.
42.2 B. On my own
46.9 C. Through special courses

11. Which of the following is closest to the type of computer organization in your school?

2.9 A. There are no computers at all in this school.
23.5 B. There are computers in some or all classrooms.
62.4 C. Computers are provided in one or more places for use by teachers with their students.
10.7 D. Computers are provided in one or more places which are staffed by specialists or resource persons.
0.5 E. Computers are used for administrative purposes only.

12. How is a computer used in your mathematics class? (Mark all that apply.)

47.5 A. Not used
13.6 B. I use it as a teaching tool to demonstrate concepts.
11.6 C. Students learn computer programming.
45.2 D. Students use software packages.
9.3 E. I use the computer for record-keeping.

13. What kinds of computer software do your students use for learning mathematics? (Mark all that apply.)

38.8 A. None
51.2 B. Drill and practice
45.9 C. Educational games to reinforce skills or concepts
19.4 D. Tutorial (to teach a skill or concept)
12.6 E. Simulation (to provide a model of a real situation)

14. Which group of students in your mathematics class makes the most use of computers in school?

25.7 A. None, my students do not use computers in school.
4.4 B. The low ability students
3.1 C. Students of average ability
8.3 D. High ability students
58.5 E. They all make equal use of computers.

FOR ITEMS 15-23, CHOOSE THE OPTION WHICH BEST DESCRIBES YOUR OPINION.

15. If we allow computers to be used in school, they may take over some of the major functions of teachers.

34.2 A. Strongly Disagree
47.4 B. Disagree
11.2 C. Undecided
5.7 D. Agree
1.5 E. Strongly Agree

16. The computer software that is available for teaching mathematics is appropriate and well-designed.

2.2 A. Strongly Disagree
16.6 B. Disagree
57.3 C. Undecided
22.6 D. Agree
1.3 E. Strongly Agree

17. Students have an opportunity to be creative when they are taught mathematics by computer.

2.8 A. Strongly Disagree
15.4 B. Disagree
54.4 C. Undecided
25.1 D. Agree
2.3 E. Strongly Agree

18. More boys than girls seem to use computers for doing mathematics.

12.0 A. Strongly Disagree
31.5 B. Disagree
46.7 C. Undecided
8.6 D. Agree
1.2 E. Strongly Agree

19. It is essential that computers become an instructional tool for all teachers of mathematics.

4.5 A. Strongly Disagree
19.7 B. Disagree
31.3 C. Undecided
35.7 D. Agree
8.9 E. Strongly Agree

20. To be successful in modern society, nearly everyone will need computer skills.

4.1 A. Strongly Disagree
14.4 B. Disagree
21.5 C. Undecided
42.4 D. Agree
17.7 E. Strongly Agree

TEACHER BACKGROUND INFORMATION

Please record your responses ON THE ANSWER SHEET in the section labelled "BACKGROUND INFORMATION".

1. For how many years will you have been teaching mathematics as of June, 1985?

5.6 A. 1-2 years
13.9 B. 3-5 years
24.1 C. 6-10 years
24.1 D. 11-15 years
32.5 E. More than 15 years

2. If you had a choice, would you avoid teaching mathematics altogether?

1.8 A. Yes
96.1 B. No
2.1 C. Undecided

3. What percent of your current teaching load is mathematics?

64.5 A. 0-20%
31.8 B. 21-40%
2.9 C. 41-60%
0.6 D. 61-80%
0.2 E. 81-100%

4. To which of the following associations do you belong? (Mark all that apply.)

1.9 A. B.C. Association of Mathematics Teachers
23.1 B. Provincial Intermediate Teachers Association
8.3 C. B.C. Primary Teachers Association
0.6 D. National Council of Teachers of Mathematics
1.2 E. Local Mathematics PSA
68.2 F. None of the above

5. Have you attended a mathematics session at a conference in the last three years?

49.6 A. Yes
49.8 B. No

6. Have you attended a workshop (other than at a conference) or an inservice day in mathematics in the last three years?

57.0 A. Yes
42.6 B. No

7. At what level should students first be taught mathematics by someone who specializes in the teaching of mathematics?

1.6 A. At no level
21.2 B. Primary
19.0 C. Intermediate
55.4 D. Junior Secondary
2.8 E. Senior Secondary

8. How many post-secondary courses in mathematics have you successfully completed? (e.g., For UBC 3 units = 2 courses)

31.6 A. 0
42.1 B. 1 or 2
19.3 C. 3-5
4.4 D. 6-9
2.5 E. 10 or more

9. How many post-secondary courses in mathematics education have you successfully completed? (e.g., For UBC 3 units = 2 courses)

18.3 A. 0
67.8 B. 1 or 2
12.5 C. 3-5
1.0 D. 6-9
0.4 E. 10 or more

QUESTIONS 10-20 REFER TO THE SPECIFIC MATHEMATICS CLASS DESIGNATED BY YOUR PRINCIPAL FOR THIS QUESTIONNAIRE.

10. Which of the following best describes the course offered to these students?

87.5 A. Full-year course, regular program
6.9 B. Full-year course, modified (slower students)
4.1 C. Full-year course, enriched
0.5 D. Semester course, regular program
0.0 E. Semester course, modified (slower students)
0.0 F. Semester course, enriched
1.1 G. Other

11. On the average, how often do you give this class tests or quizzes in mathematics?

20.0 A. Almost every day
40.9 B. Once a week
38.0 C. Once every couple of weeks
0.7 D. Once every reporting period
0.3 E. I almost never give tests or quizzes in mathematics.

12. How many mathematics periods does this class have each calendar week?

0.3 A. 3
8.3 B. 4
84.4 C. 5
4.9 D. 6
2.0 E. More than 6

13. How long is each mathematics period?

1.0 A. 30 minutes or less
71.1 B. 31-45 minutes
27.1 C. 46-60 minutes
0.7 D. 61-75 minutes
0.1 E. More than 75 minutes

QUESTIONS 14-20 REFER TO THE LAST MATHEMATICS PERIOD
DURING WHICH YOU TAUGHT THIS CLASS.

14. What percent of that mathematics period was spent on activities related to homework from the previous day (e.g., discussing, correcting)?

23.8 A. None
52.3 B. 1-10%
19.8 C. 11-25%
3.0 D. 26-50%
0.2 E. 51-75%
0.5 F. 76-100%

15. How many students did you call on to answer questions?

1.1 A. None
1.3 B. One or two
10.1 C. Less than one-quarter of the class
26.7 D. About half the class
17.3 E. Between a half and three-fourths of the class
43.6 F. Almost every student

16. What percent of that mathematics period did your students spend working individually on seatwork?

1.4 A. None
3.8 B. 1-10%
18.5 C. 11-25%
49.0 D. 26-50%
21.9 E. 51-75%
5.4 F. 76-100%

17. What percent of that mathematics period did your students spend working in small groups?

57.2 A. None
24.3 B. 1-10%
11.4 C. 11-25%
4.6 D. 26-50%
0.9 E. 51-75%
1.6 F. 76-100%

18. What percent of that mathematics period did your students spend working at stations or activity centres?

82.0 A. None
14.0 B. 1-10%
3.0 C. 11-25%
0.5 D. 26-50%
0.2 E. 51-75%
0.2 F. 76-100%

19. What percent of that mathematics period did your students spend on computational drill?

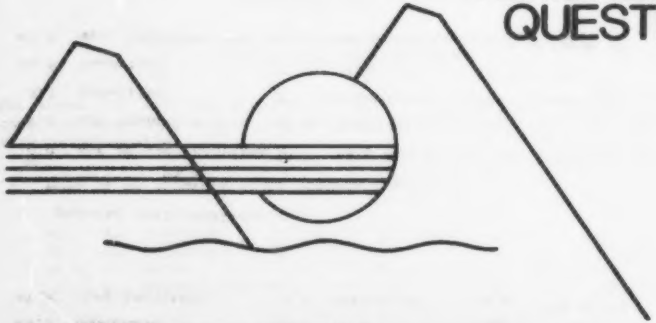
25.7 A. None
55.9 B. 1-10%
12.2 C. 11-25%
3.3 D. 26-50%
2.2 E. 51-75%
0.8 F. 76-100%

20. What percent of that mathematics period did you spend explaining new topics to the entire class?

15.8 A. None
23.2 B. 1-10%
41.3 C. 11-25%
15.9 D. 26-50%
2.6 E. 51-75%
1.1 F. 76-100%

END OF TEACHER QUESTIONNAIRE

GRADE 7
TEACHER'S GUIDE
QUESTIONNAIRE



BRITISH COLUMBIA
MATHEMATICS
ASSESSMENT
1985

SCALE B: MATHEMATICS IN SCHOOL

Please record your responses ON THE ANSWER SHEET
in the section labelled "FORM B".

For each of the items in this scale, three responses are required. Consider only the class designated by your principal for this questionnaire.

A. Tell how important you think the topic is for this class.
B. Tell how easy it is to teach the topic to this class.
C. Tell how much you like teaching the topic to this class.

1. Adding, subtracting, multiplying and dividing fractions

	A.		B.		C.
0.7	not at all important	2.2	very difficult	0.3	dislike a lot
10.0	not important	35.2	difficult	4.4	dislike
8.9	undecided	12.5	undecided	9.7	undecided
47.1	important	43.3	easy	67.8	like
33.3	very important	6.8	very easy	17.7	like a lot

2. Adding, subtracting, multiplying and dividing decimals

	A.		B.		C.
0.1	not at all important	0.6	very difficult	0.0	dislike a lot
0.5	not important	14.0	difficult	0.4	dislike
0.9	undecided	10.1	undecided	5.1	undecided
21.3	important	63.5	easy	65.2	like
77.3	very important	11.8	very easy	29.2	like a lot

3. Working with percents

	A.		B.		C.
0.1	not at all important	3.6	very difficult	0.0	dislike a lot
0.7	not important	32.7	difficult	1.2	dislike
2.9	undecided	16.1	undecided	7.2	undecided
44.1	important	42.1	easy	64.3	like
52.2	very important	5.5	very easy	27.3	like a lot

4. Learning about estimation

	A.		B.		C.
0.2	not at all important	2.3	very difficult	0.1	dislike a lot
2.3	not important	30.7	difficult	5.2	dislike
12.5	undecided	25.9	undecided	28.3	undecided
55.9	important	36.7	easy	56.8	like
29.1	very important	4.3	very easy	9.5	like a lot

5. Memorizing basic facts

	A.		B.		C.
0.7	not at all important	2.0	very difficult	1.5	dislike a lot
4.1	not important	18.6	difficult	19.1	dislike
5.0	undecided	22.8	undecided	27.4	undecided
33.5	important	44.1	easy	42.8	like
56.7	very important	12.6	very easy	9.1	like a lot

6. Solving equations

	A.		B.		C.
0.1	not at all important	4.9	very difficult	0.0	dislike a lot
1.4	not important	41.1	difficult	2.8	dislike
4.3	undecided	18.3	undecided	11.4	undecided
46.3	important	31.2	easy	56.1	like
47.9	very important	4.5	very easy	29.8	like a lot

7. Solving word problems

	A.		B.		C.
0.0	not at all important	20.0	very difficult	0.7	dislike a lot
0.4	not important	48.8	difficult	6.4	dislike
3.3	undecided	15.2	undecided	17.7	undecided
34.6	important	13.8	easy	50.2	like
61.6	very important	2.3	very easy	25.0	like a lot

8. Learning about the metric system

	A.		B.		C.
0.3	not at all important	3.9	very difficult	1.1	dislike a lot
1.1	not important	28.8	difficult	8.9	dislike
6.4	undecided	22.4	undecided	22.7	undecided
44.0	important	39.6	easy	53.9	like
48.2	very important	5.3	very easy	13.4	like a lot

9. Working with perimeter and area

	A.		B.		C.
0.1	not at all important	1.2	very difficult	0.0	dislike a lot
3.3	not important	15.4	difficult	1.2	dislike
12.4	undecided	19.1	undecided	13.3	undecided
67.1	important	54.4	easy	64.2	like
17.1	very important	10.0	very easy	21.4	like a lot

10. Doing geometry

	A.		B.		C.
0.4	not at all important	3.1	very difficult	0.3	dislike a lot
6.4	not important	15.3	difficult	2.9	dislike
22.7	undecided	26.7	undecided	13.6	undecided
56.7	important	47.8	easy	52.3	like
13.9	very important	7.1	very easy	30.9	like a lot

SCALE S: PROBLEM SOLVING

**Please record your responses ON THE ANSWER SHEET
in the section labelled "FORM S".**

For Items 1-7, mark the response which best describes your opinion about each statement with respect to the class designated by your principal for this questionnaire.

1. Most of my students enjoy problem solving.

8.1 A. Strongly Disagree
43.3 B. Disagree
21.0 C. Undecided
24.9 D. Agree
2.8 E. Strongly Agree

2. Most of my students perform well in problem solving.

6.1 A. Strongly Disagree
41.0 B. Disagree
24.5 C. Undecided
27.4 D. Agree
1.0 E. Strongly Agree

3. The textbooks I use provide adequate instruction for developing problem-solving skills.

30.5 A. Strongly Disagree
40.9 B. Disagree
10.7 C. Undecided
16.4 D. Agree
1.5 E. Strongly Agree

4. My district provides adequate assistance and resources for the teaching of problem solving.

8.6 A. Strongly Disagree
26.5 B. Disagree
33.3 C. Undecided
27.8 D. Agree
3.8 E. Strongly Agree

5. I am satisfied with my teaching of problem solving.

2.6 A. Strongly Disagree
23.3 B. Disagree
28.9 C. Undecided
41.4 D. Agree
3.7 E. Strongly Agree

6. All mathematics teachers should attend at least one workshop on problem solving each year.

7.1 A. Strongly Disagree
20.9 B. Disagree
24.1 C. Undecided
35.7 D. Agree
12.2 E. Strongly Agree

7. It is easy to teach problem solving.

11.8 A. Strongly Disagree
51.8 B. Disagree
19.8 C. Undecided
15.3 D. Agree
1.3 E. Strongly Agree

8. Which of these problem-solving strategies do you teach in your classes? (Mark all that apply.)

84.4 A. Look for a pattern
42.2 B. Guess and check
70.3 C. Make a systematic list or table
71.6 D. Solve a simpler problem
45.8 E. Work backwards

9. How many workshops on problem solving have you attended in the past year?

72.4 A. None
20.6 B. 1
5.2 C. 2
1.0 D. 3
0.8 E. More than 3

10. What sources do you use to provide students with problem-solving exercises? (Mark all that apply.)

93.4 A. Textbook
37.5 B. Mathematical contests
67.3 C. Problem-solving booklets
18.4 D. Professional journals
58.5 E. Books of puzzles

11. Which of the following do you use to motivate your students to participate in problem-solving activities? (Mark all that apply.)

40.8 A. Competitive games
41.5 B. Problem of the day or week
81.1 C. Puzzles or brain teasers
30.8 D. Library or file of interesting problems
32.0 E. Contests

12. Which of the following best characterises your teaching of problem solving in mathematics? I teach problem solving:

24.4 A. As a unit from time to time
38.1 B. Almost every day, as a regular part of the mathematics class
6.3 C. One period every 2 or 3 weeks
17.5 D. At the end of a major topic or chapter
13.8 E. One period a week

13. When you grade students' work in problem solving, for which of the following do you give marks? (Mark all that apply.)

5.6 A. I don't give partial credit. It's all or nothing.
75.2 B. For the appropriate diagram or equation
86.6 C. For the procedures used (computation, etc.).
86.7 D. For the final answer
20.4 E. For checking the answer

14. Which of the following types of problems do you assign to your students? (Mark all that apply.)

34.8 A. Problems with more than one correct answer
59.3 B. Problems which require students to collect information
89.4 C. Problems which can be solved more than one way
43.4 D. Problems which students work on collectively in groups
64.5 E. Problems with either too much or too little information

15. Which of the following activities do you have in your class? (Mark all that apply.)

14.4 A. A problem-solving center
14.9 B. A bulletin board display on problem solving
36.5 C. Problem of the week
52.5 D. Problem-solving contests within the class
51.9 E. Students make up problems for others to solve

SCALE T: CALCULATORS AND COMPUTERS

Please record your responses ON THE ANSWER SHEET
in the section labelled "FORM T".

When responding, consider only the designated class.

1. Do you own a calculator?

95.7 A. Yes
4.3 B. No

2. How often do you use a calculator outside school?

1.7 A. Never
29.2 B. Rarely (perhaps less than once a week)
43.4 C. Sometimes (a couple of times a week)
25.7 D. Frequently (almost every day)

3. In what ways do you have your students use calculators in mathematics? (Mark all that apply.)

56.4 A. Not at all
18.6 B. For drill and practice to enhance computational skills
31.4 C. To work on problems
23.7 D. For other topics such as estimating, finding patterns, and so on

4. How are students in your class provided with calculators?

34.8 A. I do not allow calculators in my class.
56.9 B. Each student may bring his or her own.
2.0 C. Each student must bring his or her own.
6.3 D. Calculators are provided for the students.

5. In what ways do you use a calculator for non-instructional school work? (Mark all that apply.)

8.0 A. None
88.2 B. To calculate students' marks, grades, and so on
58.5 C. To check students' answers on assignments
55.9 D. To prepare worksheets or tests

6. Some people say that Grade 7 students should not be allowed to use calculators in school. How do you feel about this?

21.3 A. Strongly Disagree
35.9 B. Disagree
19.4 C. Undecided
17.5 D. Agree
5.9 E. Strongly Agree

7. Some people say that if students are allowed to use calculators, then it is not necessary for them to learn how to add, subtract, multiply, or divide by hand. How do you feel about this?

64.9 A. Strongly Disagree
20.3 B. Disagree
4.6 C. Undecided
6.1 D. Agree
4.1 E. Strongly Agree

8. Do you have a computer (one that will do more than play games) at home?

24.1 A. Yes
75.8 B. No

9. What applications of computers have you had experience with? (Mark all that apply.)

7.8 A. None
73.7 B. Games
61.3 C. Word processing
74.1 D. Computer-assisted instruction
48.2 E. Programming

10. Where did you get most of your experience with computers?

9.2 A. I haven't had any experience with computers.
46.9 B. On my own
44.0 C. Through special courses

11. Which of the following is closest to the type of computer organization in your school?

2.1 A. There are no computers at all in this school.
21.0 B. There are computers in some or all classrooms.
61.8 C. Computers are provided in one or more places for use by teachers with their students.
14.7 D. Computers are provided in one or more places which are staffed by specialists or resource persons.
0.3 E. Computers are used for administrative purposes only.

12. How is a computer used in your mathematics class? (Mark all that apply.)

48.9 A. Not used
12.6 B. I use it as a teaching tool to demonstrate concepts.
18.1 C. Students learn computer programming.
42.3 D. Students use software packages.
14.9 E. I use the computer for record-keeping.

13. What kinds of computer software do your students use for learning mathematics? (Mark all that apply.)

44.6 A. None
41.4 B. Drill and practice
42.6 C. Educational games to reinforce skills or concepts
23.0 D. Tutorial (to teach a skill or concept)
17.3 E. Simulation (to provide a model of a real situation)

14. Which group of students in your mathematics class makes the most use of computers in school?

21.2 A. None, my students do not use computers in school.
6.1 B. The low ability students
5.1 C. Students of average ability
15.0 D. High ability students
52.6 E. They all make equal use of computers.

FOR ITEMS 15-20, CHOOSE THE OPTION WHICH BEST DESCRIBES YOUR OPINION.

15. If we allow computers to be used in school, they may take over some of the major functions of teachers.

38.6 A. Strongly Disagree
45.0 B. Disagree
8.8 C. Undecided
6.3 D. Agree
1.3 E. Strongly Agree

16. The computer software that is available for teaching mathematics is appropriate and well-designed.

4.6 A. Strongly Disagree
20.6 B. Disagree
54.9 C. Undecided
18.7 D. Agree
1.3 E. Strongly Agree

17. Students have an opportunity to be creative when they are taught mathematics by computer.

2.9 A. Strongly Disagree
15.2 B. Disagree
51.2 C. Undecided
26.5 D. Agree
4.2 E. Strongly Agree

18. More boys than girls seem to use computers for doing mathematics.

7.4 A. Strongly Disagree
22.3 B. Disagree
47.2 C. Undecided
21.2 D. Agree
1.9 E. Strongly Agree

19. It is essential that computers become an instructional tool for all teachers of mathematics.

3.6 A. Strongly Disagree
17.4 B. Disagree
30.6 C. Undecided
37.0 D. Agree
11.4 E. Strongly Agree

20. To be successful in modern society, nearly everyone will need computer skills.

5.3 A. Strongly Disagree
14.7 B. Disagree
19.4 C. Undecided
43.5 D. Agree
17.0 E. Strongly Agree

TEACHER BACKGROUND INFORMATION

Please record your responses ON THE ANSWER SHEET in
the section labelled "BACKGROUND INFORMATION".

1. For how many years will you have been teaching mathematics as of June, 1985?

5.4 A. 1-2 years
11.9 B. 3-5 years
28.4 C. 6-10 years
25.6 D. 11-15 years
28.6 E. More than 15 years

2. If you had a choice, would you avoid teaching mathematics altogether?

1.7 A. Yes
96.3 B. No
1.9 C. Undecided

3. What percent of your current teaching load is mathematics?

62.4 A. 0-20%
30.3 B. 21-40%
4.0 C. 41-60%
1.1 D. 61-80%
2.0 E. 81-100%

4. To which of the following associations do you belong? (Mark all that apply.)

3.4 A. B.C. Association of Mathematics Teachers
26.6 B. Provincial Intermediate Teachers Association
1.3 C. B.C. Primary Teachers Association
2.3 D. National Council of Teachers of Mathematics
3.0 E. Local Mathematics PSA
65.1 F. None of the above

5. Have you attended a mathematics session at a conference in the last three years?

48.8 A. Yes
50.6 B. No
0.6 Omit

6. Have you attended a workshop (other than at a conference) or an inservice day in mathematics in the last three years?

58.1 A. Yes
41.5 B. No
0.4 Omit

7. At what level should students first be taught mathematics by someone who specializes in the teaching of mathematics?

1.3 A. At no level
17.0 B. Primary
25.7 C. Intermediate
51.6 D. Junior Secondary
4.4 E. Senior Secondary

8. How many post-secondary courses in mathematics have you successfully completed? (e.g., For UBC 3 units = 2 courses)

22.8 A. 0
40.6 B. 1 or 2
25.2 C. 3-5
7.4 D. 6-9
4.1 E. 10 or more

9. How many post-secondary courses in mathematics education have you successfully completed? (e.g., For UBC 3 units = 2 courses)

22.8 A. 0
61.5 B. 1 or 2
12.6 C. 3-5
2.3 D. 6-9
0.8 E. 10 or more

QUESTIONS 10-20 REFER TO THE SPECIFIC MATHEMATICS CLASS
DESIGNATED BY YOUR PRINCIPAL FOR THIS QUESTIONNAIRE.

10. Which of the following best describes the course offered to these students?

90.3 A. Full-year course, regular program
5.2 B. Full-year course, modified (slower students)
2.9 C. Full-year course, enriched
0.3 D. Semester course, regular program
- E. Semester course, modified (slower students)
- F. Semester course, enriched
1.3 G. Other

11. On the average, how often do you give this class tests or quizzes in mathematics?

10.7 A. Almost every day
45.7 B. Once a week
42.7 C. Once every couple of weeks
0.7 D. Once every reporting period
0.2 E. I almost never give tests or quizzes in mathematics.

12. How many mathematics periods does this class have each calendar week?

1.9 A. 3
8.1 B. 4
73.7 C. 5
12.7 D. 6
3.4 E. More than 6

13. How long is each mathematics period?

1.1 A. 30 minutes or less
58.0 B. 31-45 minutes
39.3 C. 46-60 minutes
1.4 D. 61-75 minutes
0.1 E. More than 75 minutes

QUESTIONS 14-20 REFER TO THE LAST MATHEMATICS PERIOD
DURING WHICH YOU TAUGHT THIS CLASS.

14. What percent of that mathematics period was spent on activities related to homework from the previous day (e.g., discussing, correcting)?

8.3 A. None
45.7 B. 1-10%
36.7 C. 11-25%
6.8 D. 26-50%
1.5 E. 51-75%
1.0 F. 76-100%

15. How many students did you call on to answer questions?

1.8 A. None
0.8 B. One or two
14.9 C. Less than one-quarter of the class
31.0 D. About half the class
17.6 E. Between a half and three-fourths of the class
33.9 F. Almost every student

16. What percent of that mathematics period did your students spend working individually on seatwork?

1.4 A. None
4.4 B. 1-10%
23.8 C. 11-25%
44.2 D. 26-50%
22.1 E. 51-75%
4.0 F. 76-100%

17. What percent of that mathematics period did your students spend working in small groups?

57.5 A. None
26.4 B. 1-10%
9.2 C. 11-25%
4.1 D. 26-50%
1.0 E. 51-75%
1.8 F. 76-100%

18. What percent of that mathematics period did your students spend working at stations or activity centres?

90.9 A. None
7.4 B. 1-10%
0.7 C. 11-25%
0.5 D. 26-50%
0.1 E. 51-75%
0.4 F. 76-100%

19. What percent of that mathematics period did your students spend on computational drill?

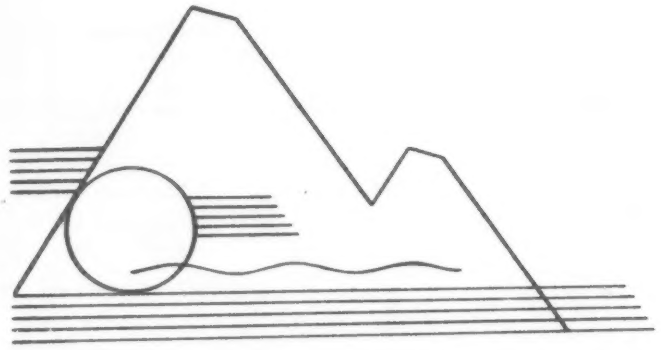
50.8 A. None
39.1 B. 1-10%
7.3 C. 11-25%
1.9 D. 26-50%
0.6 E. 51-75%
0.2 F. 76-100%

20. What percent of that mathematics period did you spend explaining new topics to the entire class?

12.3 A. None
18.5 B. 1-10%
45.1 C. 11-25%
21.3 D. 26-50%
2.1 E. 51-75%
0.7 F. 76-100%

END OF TEACHER QUESTIONNAIRE

GRADE 10
TEACHER'S GUIDE
QUESTIONNAIRE



BRITISH COLUMBIA

MATHEMATICS ASSESSMENT 1985

- 2 -

SCALE B: MATHEMATICS IN SCHOOL

Please record your responses ON THE ANSWER SHEET in the section labelled "FORM B".

For each of the items in this scale, three responses are required. Consider only the class designated by your principal for this questionnaire.

A. Tell how important you think the topic is for this class.
B. Tell how easy it is to teach the topic to this class.
C. Tell how much you like teaching the topic to this class.

1. Solving equations

A.		B.		C.	
0.4	not at all important	4.5	very difficult	0.6	dislike a lot
4.1	not important	31.3	difficult	2.7	dislike
3.1	undecided	12.5	undecided	7.9	undecided
27.4	important	45.4	easy	58.5	like
64.9	very important	6.4	very easy	30.3	like a lot

2. Finding area and volume

A.		B.		C.	
1.2	not at all important	0.5	very difficult	0.2	dislike a lot
8.7	not important	14.4	difficult	4.5	dislike
9.5	undecided	18.9	undecided	24.3	undecided
61.5	important	57.4	easy	60.0	like
19.1	very important	8.9	very easy	11.0	like a lot

3. Working with fractions, decimals and percent

A.		B.		C.	
0.6	not at all important	2.7	very difficult	0.3	dislike a lot
3.4	not important	29.9	difficult	14.4	dislike
4.0	undecided	19.7	undecided	24.4	undecided
44.6	important	39.7	easy	51.9	like
47.3	very important	8.0	very easy	9.0	like a lot

4. Factoring

A.		B.		C.	
5.9	not at all important	7.3	very difficult	1.5	dislike a lot
8.1	not important	27.2	difficult	5.4	dislike
9.0	undecided	17.9	undecided	16.7	undecided
43.4	important	41.2	easy	51.9	like
33.5	very important	6.4	very easy	24.5	like a lot

5. Constructing geometric figures

A.		B.		C.	
6.0	not at all important	1.5	very difficult	0.6	dislike a lot
27.8	not important	14.9	difficult	8.6	dislike
30.7	undecided	31.0	undecided	31.5	undecided
30.4	important	46.2	easy	47.8	like
5.1	very important	6.4	very easy	11.5	like a lot

6. Working with exponents

A.		B.		C.	
3.4	not at all important	3.5	very difficult	0.5	dislike a lot
6.1	not important	25.2	difficult	3.9	dislike
8.5	undecided	16.9	undecided	18.3	undecided
51.4	important	47.4	easy	59.5	like
30.6	very important	7.1	very easy	17.7	like a lot

7. Constructing graphs

A.		B.		C.	
1.0	not at all important	1.2	very difficult	0.3	dislike a lot
4.3	not important	17.6	difficult	2.3	dislike
12.0	undecided	20.6	undecided	16.9	undecided
56.2	important	52.6	easy	61.7	like
26.5	very important	8.0	very easy	18.8	like a lot

8. Estimating answers

A.		B.		C.	
1.6	not at all important	5.2	very difficult	1.1	dislike a lot
5.6	not important	29.3	difficult	9.2	dislike
13.1	undecided	29.4	undecided	36.9	undecided
53.7	important	32.2	easy	47.1	like
25.9	very important	3.9	very easy	5.7	like a lot

9. Solving word problems

A.		B.		C.	
0.1	not at all important	28.6	very difficult	1.8	dislike a lot
1.0	not important	47.4	difficult	7.8	dislike
4.3	undecided	11.0	undecided	13.7	undecided
40.7	important	10.8	easy	51.4	like
53.7	very important	2.3	very easy	25.2	like a lot

10. Working with congruent and similar figures

A.		B.		C.	
4.1	not at all important	2.3	very difficult	0.5	dislike a lot
16.2	not important	20.2	difficult	6.6	dislike
29.5	undecided	37.0	undecided	33.2	undecided
45.0	important	37.0	easy	50.3	like
5.3	very important	3.7	very easy	9.5	like a lot

SCALE S: PROBLEM SOLVING

**Please record your responses ON THE ANSWER SHEET
in the section labelled "FORM S".**

For Items 1-7, mark the response which best describes your opinion about each statement with respect to the class designated by your principal for this questionnaire.

1. Most of my students enjoy problem solving.

14.1 A. Strongly Disagree
53.7 B. Disagree
14.5 C. Undecided
16.7 D. Agree
1.0 E. Strongly Agree

2. Most of my students perform well in problem solving.

11.3 A. Strongly Disagree
40.4 B. Disagree
24.0 C. Undecided
22.5 D. Agree
1.6 E. Strongly Agree

3. The textbooks I use provide adequate instruction for developing problem-solving skills.

30.8 A. Strongly Disagree
31.2 B. Disagree
8.7 C. Undecided
26.3 D. Agree
3.0 E. Strongly Agree

4. My district provides adequate assistance and resources for the teaching of problem solving.

15.0 A. Strongly Disagree
24.3 B. Disagree
36.2 C. Undecided
22.0 D. Agree
2.5 E. Strongly Agree

5. I am satisfied with my teaching of problem solving.

1.8 A. Strongly Disagree
16.9 B. Disagree
23.9 C. Undecided
50.8 D. Agree
6.5 E. Strongly Agree

6. All mathematics teachers should attend at least one workshop on problem solving each year.

7.7 A. Strongly Disagree
25.9 B. Disagree
26.5 C. Undecided
29.7 D. Agree
10.1 E. Strongly Agree

7. It is easy to teach problem solving.

14.4 A. Strongly Disagree
53.0 B. Disagree
13.8 C. Undecided
17.4 D. Agree
1.3 E. Strongly Agree

8. Which of these problem-solving strategies do you teach in your classes? (Mark all that apply.)

76.4 A. Look for a pattern
29.5 B. Guess and check
80.4 C. Make a systematic list or table
65.6 D. Solve a simpler problem
28.9 E. Work backwards

9. How many workshops on problem solving have you attended in the past year?

78.7 A. None
17.7 B. 1
2.4 C. 2
0.1 D. 3
1.0 E. More than 3

10. What sources do you use to provide students with problem-solving exercises? (Mark all that apply.)

94.3 A. Textbook
40.0 B. Mathematical contests
54.2 C. Problem-solving booklets
17.4 D. Professional journals
42.4 E. Books of puzzles

11. Which of the following do you use to motivate your students to participate in problem-solving activities? (Mark all that apply.)

17.3 A. Competitive games
35.1 B. Problem of the day or week
58.9 C. Puzzles or brain teasers
37.1 D. Library or file of interesting problems
36.7 E. Contests

12. Which of the following best characterizes your teaching of problem solving in mathematics? I teach problem solving:

46.9 A. As a unit from time to time
28.6 B. Almost every day, as a regular part of the mathematics class
2.8 C. One period every 2 or 3 weeks
17.6 D. At the end of a major topic or chapter
4.1 E. One period a week

13. When you grade students' work in problem solving, for which of the following do you give marks? (Mark all that apply.)

3.0 A. I don't give partial credit. It's all or nothing.
89.5 B. For the appropriate diagram or equation
94.4 C. For the procedures used (computation, etc.)
89.8 D. For the final answer
35.3 E. For checking the answer

14. Which of the following types of problems do you assign to your students? (Mark all that apply.)

39.5 A. Problems with more than one correct answer
48.3 B. Problems which require students to collect information
90.0 C. Problems which can be solved more than one way
31.9 D. Problems which students work on collectively in groups
43.4 E. Problems with either too much or too little information

15. Which of the following activities do you have in your class? (Mark all that apply.)

7.6 A. A problem-solving center
22.3 B. A bulletin board display on problem solving
40.4 C. Problem of the week
40.1 D. Problem-solving contests within the class
31.4 E. Students make up problems for others to solve

SCALE T: CALCULATORS AND COMPUTERS

Please record your responses ON THE ANSWER SHEET
in the section labelled "FORM T".

When responding, consider only the designated class.

1. Do you own a calculator?

97.2 A. Yes
2.8 B. No

2. How often do you use a calculator outside school?

1.3 A. Never
20.0 B. Rarely (perhaps less than once a week)
45.0 C. Sometimes (a couple of times a week)
33.6 D. Frequently (almost every day)

3. In what ways do you have your students use calculators in mathematics? (Mark all that apply.)

19.0 A. Not at all
26.6 B. For drill and practice to enhance computational skills
74.2 C. To work on problems
37.2 D. For other topics such as estimating, finding patterns, and so on

4. How are students in your class provided with calculators?

14.6 A. I do not allow calculators in my class.
70.3 B. Each student may bring his or her own.
11.1 C. Each student must bring his or her own.
4.1 D. Calculators are provided for the students.

5. In what ways do you use a calculator for non-instructional school work? (Mark all that apply.)

4.9 A. None
91.2 B. To calculate students' marks, grades, and so on
66.3 C. To check students' answers on assignments
69.7 D. To prepare worksheets or tests

6. Some people say that Grade 10 students should not be allowed to use calculators in school. How do you feel about this?

38.7 A. Strongly Disagree
35.6 B. Disagree
12.1 C. Undecided
9.8 D. Agree
3.9 E. Strongly Agree

7. Some people say that if students are allowed to use calculators, then it is not necessary for them to learn how to add, subtract, multiply, or divide by hand. How do you feel about this?

68.1 A. Strongly Disagree
22.9 B. Disagree
3.3 C. Undecided
4.0 D. Agree
1.6 E. Strongly Agree

8. Do you have a computer (one that will do more than play games) at home?

33.8 A. Yes
66.1 B. No

9. What applications of computers have you had experience with? (Mark all that apply.)

10.0 A. None
66.2 B. Games
55.8 C. Word processing
64.6 D. Computer-assisted instruction
70.8 E. Programming

10. Where did you get most of your experience with computers?

11.1 A. I haven't had any experience with computers.
51.2 B. On my own
37.7 C. Through special courses

11. Which of the following is closest to the type of computer organization in your school?

- A. There are no computers at all in this school.
10.5 B. There are computers in some or all classrooms.
55.3 C. Computers are provided in one or more places for use by teachers with their students.
33.1 D. Computers are provided in one or more places which are staffed by specialists or resource persons.
1.1 E. Computers are used for administrative purposes only.

12. How is a computer used in your mathematics class? (Mark all that apply.)

76.0 A. Not used
8.2 B. I use it as a teaching tool to demonstrate concepts.
6.7 C. Students learn computer programming.
11.2 D. Students use software packages.
14.3 E. I use the computer for record-keeping.

13. What kinds of computer software do your students use for learning mathematics? (Mark all that apply.)

82.5 A. None
9.2 B. Drill and practice
6.3 C. Educational games to reinforce skills or concepts
9.7 D. Tutorial (to teach a skill or concept)
4.4 E. Simulation (to provide a model of a real situation)

14. Which group of students in your mathematics class makes the most use of computers in school?

45.9 A. None, my students do not use computers in school.
3.4 B. The low ability students
9.1 C. Students of average ability
24.9 D. High ability students
16.7 E. They all make equal use of computers.

FOR ITEMS 15-20, CHOOSE THE OPTION WHICH BEST DESCRIBES YOUR OPINION.

15. If we allow computers to be used in school, they may take over some of the major functions of teachers.

39.5 A. Strongly Disagree
42.0 B. Disagree
10.4 C. Undecided
6.8 D. Agree
1.3 E. Strongly Agree

16. The computer software that is available for teaching mathematics is appropriate and well-designed.

10.8 A. Strongly Disagree
24.1 B. Disagree
57.0 C. Undecided
8.1 D. Agree
- E. Strongly Agree

17. Students have an opportunity to be creative when they are taught mathematics by computer.

3.1 A. Strongly Disagree
13.3 B. Disagree
51.6 C. Undecided
28.3 D. Agree
3.7 E. Strongly Agree

18. More boys than girls seem to use computers for doing mathematics.

3.6 A. Strongly Disagree
10.1 B. Disagree
55.0 C. Undecided
28.9 D. Agree
2.4 E. Strongly Agree

19. It is essential that computers become an instructional tool for all teachers of mathematics.

4.3 A. Strongly Disagree
21.5 B. Disagree
27.8 C. Undecided
35.8 D. Agree
10.5 E. Strongly Agree

20. To be successful in modern society, nearly everyone will need computer skills.

3.9 A. Strongly Disagree
22.3 B. Disagree
20.2 C. Undecided
39.5 D. Agree
14.2 E. Strongly Agree

TEACHER BACKGROUND INFORMATION

Please record your responses ON THE ANSWER SHEET in the section labelled "BACKGROUND INFORMATION".

1. For how many years will you have been teaching mathematics as of June, 1985?

7.5 A. 1-2 years
14.2 B. 3-5 years
17.9 C. 6-10 years
21.2 D. 11-15 years
39.2 E. More than 15 years

2. If you had a choice, would you avoid teaching mathematics altogether?

2.9 A. Yes
94.6 B. No
2.6 C. Undecided

3. What percent of your current teaching load is mathematics?

12.5 A. 0-20%
14.4 B. 21-40%
13.0 C. 41-60%
11.4 D. 61-80%
48.5 E. 81-100%

4. To which of the following associations do you belong? (Mark all that apply.)

27.3 A. B.C. Association of Mathematics Teachers
0.8 B. Provincial Intermediate Teachers Association
0.2 C. B.C. Primary Teachers Association
13.0 D. National Council of Teachers of Mathematics
19.2 E. Local Mathematics PSA
59.2 F. None of the above

5. Have you attended a mathematics session at a conference in the last three years?

56.1 A. Yes
43.8 B. No

6. Have you attended a workshop (other than at a conference) or an inservice day in mathematics in the last three years?

62.8 A. Yes
37.0 B. No

7. At what level should students first be taught mathematics by someone who specializes in the teaching of mathematics?

0.9 A. At no level
28.3 B. Primary
41.1 C. Intermediate
26.7 D. Junior Secondary
3.0 E. Senior Secondary

8. How many post-secondary courses in mathematics have you successfully completed? (e.g., For UBC 3 units = 2 courses)

4.5 A. 0
15.7 B. 1 or 2
19.7 C. 3-5
19.7 D. 6-9
40.4 E. 10 or more

9. How many post-secondary courses in mathematics education have you successfully completed? (e.g., For UBC 3 units = 2 courses)

24.1 A. 0
45.5 B. 1 or 2
17.9 C. 3-5
7.2 D. 6-9
5.3 E. 10 or more

QUESTIONS 10-20 REFER TO THE SPECIFIC MATHEMATICS CLASS DESIGNATED BY YOUR PRINCIPAL FOR THIS QUESTIONNAIRE.

10. Which of the following best describes the course offered to these students?

54.6 A. Full-year course, regular program
18.7 B. Full-year course, modified (slower students)
8.7 C. Full-year course, enriched
10.5 D. Semester course, regular program
4.9 E. Semester course, modified (slower students)
1.5 F. Semester course, enriched
1.1 G. Other

11. On the average, how often do you give this class tests or quizzes in mathematics?

7.8 A. Almost every day
38.7 B. Once a week
53.0 C. Once every couple of weeks
0.3 D. Once every reporting period
0.2 E. I almost never give tests or quizzes in mathematics.

12. How many mathematics periods does this class have each calendar week?

61.4 A. 3
16.7 B. 4
13.9 C. 5
7.2 D. 6
0.8 E. More than 6

13. How long is each mathematics period?

- A. 30 minutes or less
2.2 B. 31-45 minutes
89.8 C. 46-60 minutes
7.0 D. 61-75 minutes
0.9 E. More than 75 minutes

QUESTIONS 14-20 REFER TO THE LAST MATHEMATICS PERIOD
DURING WHICH YOU TAUGHT THIS CLASS.

14. What percent of that mathematics period was spent on activities related to homework from the previous day (e.g., discussing, correcting)?

6.2 A. None
35.9 B. 1-10%
49.8 C. 11-25%
6.3 D. 26-50%
1.7 E. 51-75%
0.2 F. 76-100%

15. How many students did you call on to answer questions?

3.6 A. None
4.5 B. One or two
33.9 C. Less than one-quarter of the class
27.8 D. About half the class
11.6 E. Between a half and three-fourths of the class
18.6 F. Almost every student

16. What percent of that mathematics period did your students spend working individually on seatwork?

1.0 A. None
4.5 B. 1-10%
21.7 C. 11-25%
41.2 D. 26-50%
25.6 E. 51-75%
6.0 F. 76-100%

17. What percent of that mathematics period did your students spend working in small groups?

60.0 A. None
21.4 B. 1-10%
10.9 C. 11-25%
3.9 D. 26-50%
2.2 E. 51-75%
1.5 F. 76-100%

18. What percent of that mathematics period did your students spend working at stations or activity centres?

96.7 A. None
1.9 B. 1-10%
0.3 C. 11-25%
0.3 D. 26-50%
0.4 E. 51-75%
0.3 F. 76-100%

19. What percent of that mathematics period did your students spend on computational drill?

76.6 A. None
17.4 B. 1-10%
3.7 C. 11-25%
1.6 D. 26-50%
0.3 E. 51-75%
0.3 F. 76-100%

20. What percent of that mathematics period did you spend explaining new topics to the entire class?

11.1 A. None
14.5 B. 1-10%
44.0 C. 11-25%
24.9 D. 26-50%
4.9 E. 51-75%
0.6 F. 76-100%

END OF TEACHER QUESTIONNAIRE

APPENDIX K

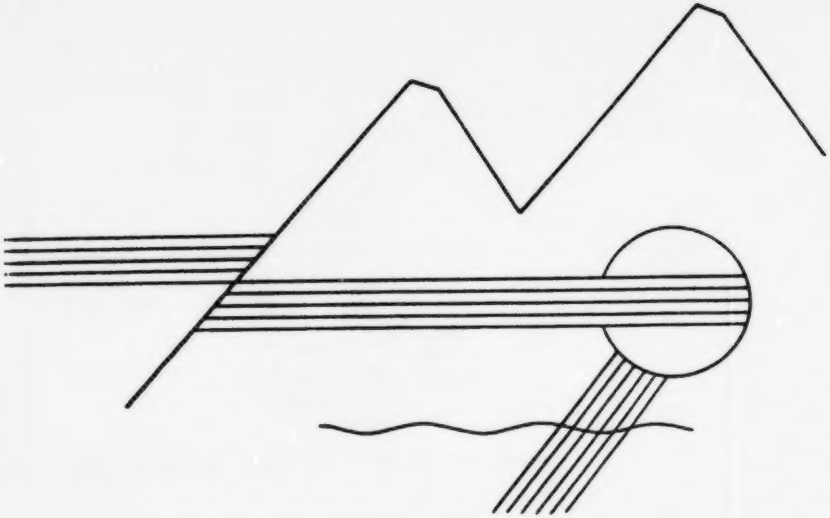
ALTERNATE TEST FORMS

BRITISH COLUMBIA

MATHEMATICS ASSESSMENT 1985

GRADE 4

Q-1



PART A - BACKGROUND QUESTIONS
GRADE 4

1. Are you a boy or a girl? Check the box that applies.

GIRL ☐ BOY ☐

2. Which one of the following best describes how well you feel you do in mathematics? Check the box that applies.

☐ Very Well ☐ Above Average ☐ Average ☐ Below Average ☐ Poor

3. What do you think are the most important reasons for studying mathematics?

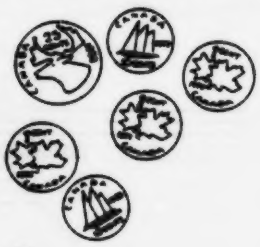
4. When you start work on a word problem, what do you do first?

5. When you finish working on a word problem, what is the last thing you do?

PART B - ACHIEVEMENT SURVEY
GRADE 4

CIRCLE THE CORRECT RESPONSE IN ITEMS 1 TO 3.

1. What is the total value of the coins shown below?



- A. 43¢
- B. 38¢
- C. 75¢
- D. 48¢
- E. I don't know.

2. Which one of the following is an odd number?

- A. 38
- B. 45
- C. 42
- D. 36
- E. I don't know.

3. Which one of the following is the smallest number that can be made using all the digits 4, 3, 9, 1?

- A. 1934
- B. 1439
- C. 1349
- D. 1943
- E. I don't know.

In this part of the booklet there are some number combinations. Please write a short story to tell how each combination might be used. Here is an example:

5 + 2 Story:
Jane had 5 apples and her friend gave her 2 more. How many apples did Jane have altogether?

4. 9 x 3 Story:

5. 13 - 7 Story:

6. 9 ÷ 3 Story:

7. 28 + 84 Story:

8. 84 - 28 Story:

9. 84 ÷ 28 Story:

10. 84 x 28 Story:

In this next part of the booklet, please put a ring around the way that shows how you would work out the problem.

Here is an example:

Linda has 5 records and Sandra gives her 3 more.

How do you work out how many records Linda has altogether?

5 ÷ 3	3 + 5
8 - 5	3 x 5
[✓ 5 + 3]	8 - 3
5 - 3	4 + 4

11. A bar of chocolate can be broken into 12 squares.

There are 3 squares in a row.

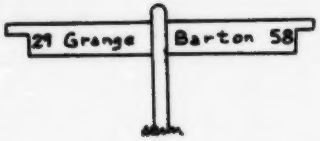
How do you work out how many rows there are?

12 + 3	3 x 4
12 x 3	3 - 12
6 + 6	12 ÷ 3
12 - 3	3 ÷ 12

12. The signpost shows that it is 29 km west to Grange and 58 km east to Barton.

How do you work out how many kilometres it is from Grange to Barton?

29 + 58	58 ÷ 29
58 - 29	29 x 2
29 ÷ 58	58 + 29
58 x 29	87 - 29



13. John is cycling 8 km home from school. He stops to rest after 2 km.

How do you work out how much farther John has to go?

8 + 2	2 x 4
2 ÷ 8	8 - 2
8 x 2	2 + 6
2 - 8	8 ÷ 2

14. 286 people are coming to see the school play. The chairs are arranged in rows, and there are 26 chairs in each row.

How do you work out how many rows are needed?

26 x 286	26 + 26
26 ÷ 286	286 - 26
26 + 286	26 x 11
26 - 286	286 ÷ 26

15. A bucket holds 8 litres of water. 4 buckets of water are emptied into a tub.

How do you work out how many litres of water are in the tub?

8 x 4	4 ÷ 8
12 - 8	8 ÷ 4
8 + 4	4 x 8
4 + 4	8 - 4

16. The Klassen family have to drive 261 km to get from Victoria to Campbell River. After driving 87 km they stop for lunch.

How do you work out how far they still have to drive?

87 x 3	261 + 87
87 ÷ 261	261 - 87
261 x 87	261 ÷ 87
87 - 261	87 + 174

17. A shop makes sandwiches. You can choose from 3 kinds of bread and 6 kinds of filling.

How do you work out how many different sandwiches you could choose?

3 x 6	6 - 3
6 + 3	3 - 6
18 ÷ 3	6 ÷ 3
6 x 3	3 + 3

18. A gardener has 391 daffodils. These are to be planted in 23 flowerbeds. Each flowerbed is to have the same number of daffodils.

How do you work out how many daffodils will be planted in each flowerbed?

391 - 23	23 ÷ 391
23 - 391	391 x 23
391 + 23	23 + 23
23 x 17	391 ÷ 23

19. A tray used for baking muffins will hold 56 muffins. A baker fills 28 trays.

How do you work out how many muffins he will bake?

56 ÷ 28	84 - 28
28 ÷ 56	56 x 28
56 + 28	56 + 56
28 x 56	56 - 28

20. Pat has 9 stickers. Fran has 17.

How do you work out how many more stickers Pat needs to have the same number as Fran?

17 ÷ 9	17 + 9
9 x 2	9 x 17
17 - 9	9 ÷ 17
9 - 17	9 + 17

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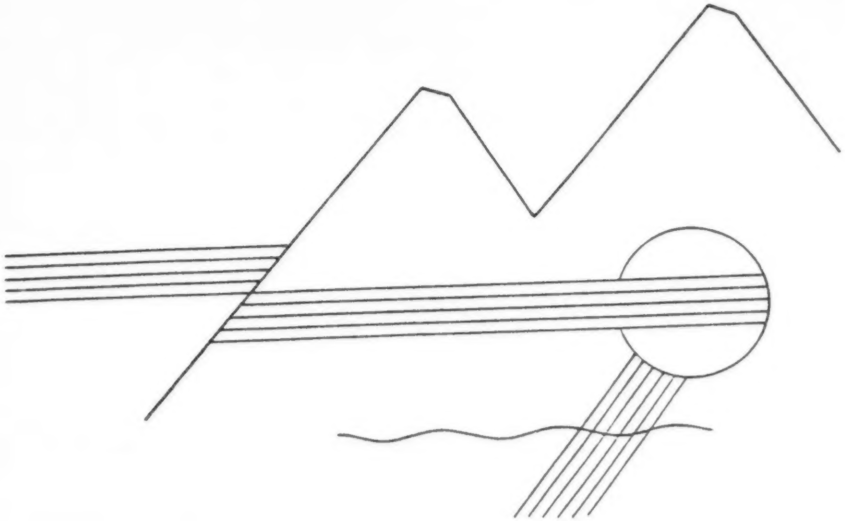
BRITISH COLUMBIA
MATHEMATICS ASSESSMENT 1985

GRADE 4
Q-2



PART A - BACKGROUND QUESTIONS
GRADE 4

1. Are you a boy or a girl? Check the box that applies.

GIRL ☐ BOY ☐

2. Which one of the following best describes how well you feel you do in mathematics? Check the box that applies.

☐ Very Well ☐ Above Average ☐ Average ☐ Below Average ☐ Poor

3. What do you think are the most important reasons for studying mathematics?

4. When you start work on a word problem, what do you do first?

5. When you finish working on a word problem, what is the last thing you do?

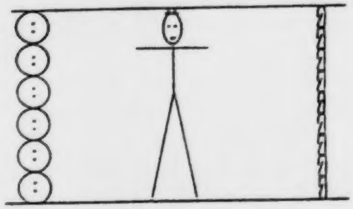
15. On Monday, 185 people saw the morning whale shows and 412 people saw the afternoon whale shows. How many people saw the whale shows that day?

16. Susan paid a total of $20.00 for 8 tickets to the same movie. Find the cost of each ticket.

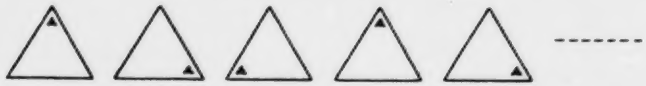
17. Bob bought 1 candy bar and 2 bottles of soda pop for $1.55. If he had bought 2 candy bars with 2 bottles of soda pop it would have cost $2.00. How much did one bottle of soda pop cost?

18. Jerry has a total of 24 golf balls and tennis balls. If he has 4 more tennis balls than golf balls, how many of each does Jerry have?

19. The stickman below is Mr. Big. He is 9 paper clips tall or 6 buttons tall. There is another stickperson, Mr. Short, who is 6 paper clips tall. How many buttons tall would he be?



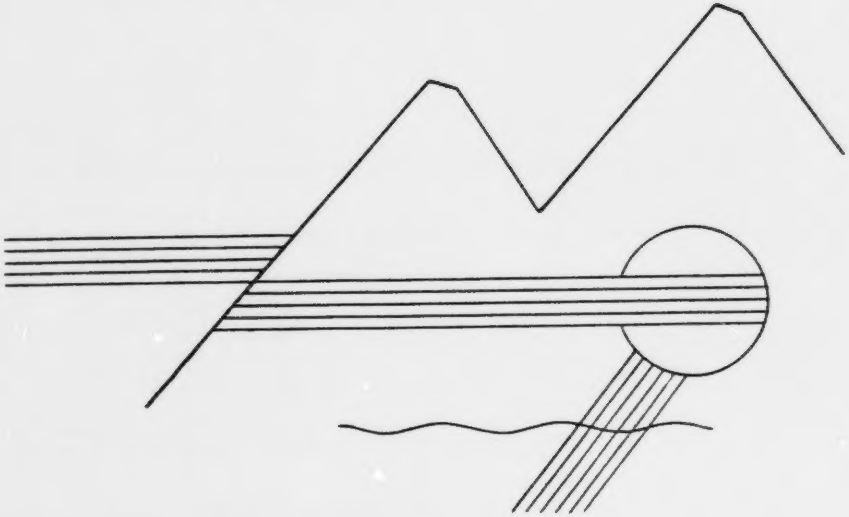
20. Draw the figure which comes next.



21. I am a number between 25 and 40. I have a remainder of 2 when divided by both 6 and 9. Who am I?

BRITISH COLUMBIA
MATHEMATICS ASSESSMENT 1985

GRADE 7
Q-1



PART A - BACKGROUND QUESTIONS
GRADE 7

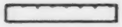
1. Are you a boy or a girl? Check the box that applies.

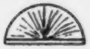
GIRL ☐ BOY ☐

2. What do you think are the most important reasons for studying mathematics?

3. The questions later in the booklet ask you to do some work with a ruler and protractor. What activities have you done in school this year using these instruments?

4. What geometry instruments do you own? Check each one you own.

☐ ruler 

☐ protractor 

☐ compass

☐ triangle

☐ triangle

☐ other. Tell what kind.

PART B - ACHIEVEMENT SURVEY
GRADE 7

CIRCLE THE CORRECT RESPONSE IN QUESTIONS 1 TO 3.

1. By rounding off to the nearest ten, an estimate of 91 x 29 would be ...

A. 270
B. 279
C. 2 700
D. 27 000
E. I don't know.

2. If John had 2300 marbles, how many bags of 10 marbles each could he make?

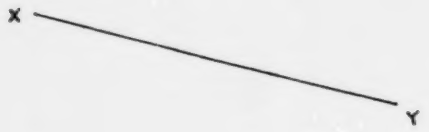
A. 23
B. 230
C. 2 300
D. 23 000
E. I don't know.

3. Sue has 58¢. If apples cost 11¢ each, what is the greatest number of whole apples that Sue can buy?

A. 4
B. 5
C. 6
D. 47
E. I don't know.

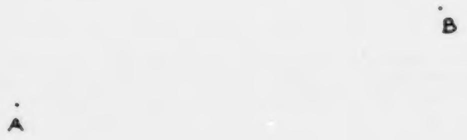
Please put your answer in the space provided. Use a sharp pencil and the ruler and protractor provided for you. You may have to draw extra lines in some diagrams; show all your work. You may keep the ruler and protractor when you are finished.

4. Determine the length of segment XY, to the nearest centimetre.



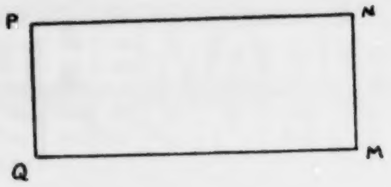
Answer:____________

5. Determine the distance from point A to point B, to the nearest millimetre.



Answer:____________

6. Determine the length of rectangle MNPQ, to the nearest millimetre.

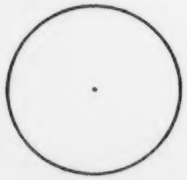


Answer: ___________

7. Using A as one end point, draw a segment 67 mm long.

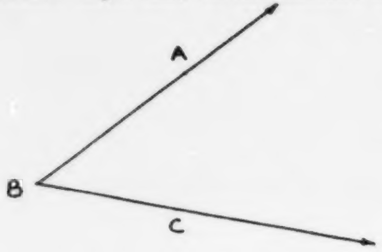
A .

8. Determine the radius of the circle, to the nearest millimetre.



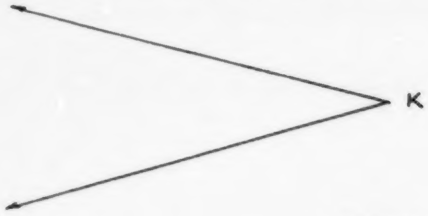
Answer: ___________

9. Measure angle ABC, to the nearest degree.



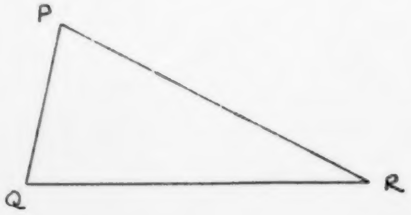
Answer: ___________

10. Measure ∠K, to the nearest degree.



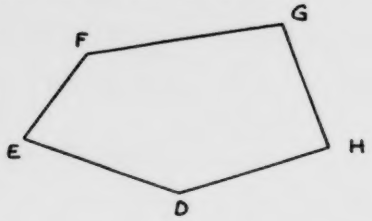
Answer: ___________

11. Measure ∠Q, to the nearest degree.



Answer: ___________

12. **Measure ∠D, to the nearest degree.**



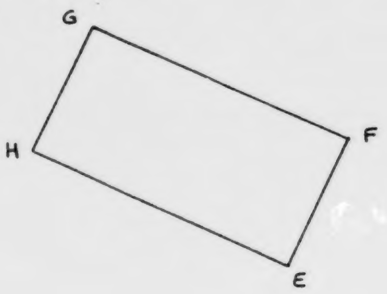
Answer: ___________

13. Use the protractor to draw an angle of 37°.

14. Use the protractor to draw a right angle.

15. Use your ruler and protractor to construct a square in which each side is 4 cm long.

16. **Determine the area of rectangle EFGH, to the nearest square centimetre.**



Answer: ___________

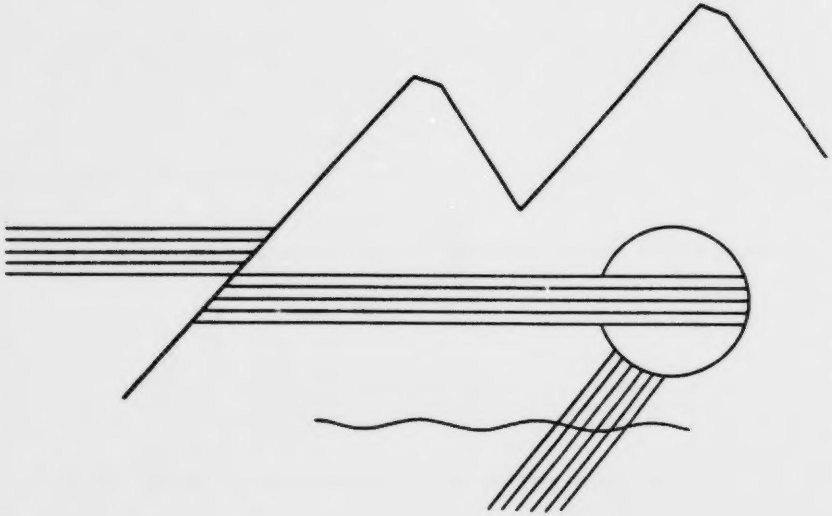
17. Fred had a problem. His teacher asked him to use a ruler and protractor to construct a triangle in which each side was 5 cm long.

Write down some things you could tell Fred to help him out.

If you can do Fred's problem, show it below.

BRITISH COLUMBIA
MATHEMATICS ASSESSMENT 1985

GRADE 7
Q-2



PART A - BACKGROUND QUESTIONS
GRADE 7

1. Are you a boy or a girl? Check the box that applies.

GIRL ☐ BOY ☐

2. Which one of the following best describes how well you feel you do in mathematics? Check the box that applies.

☐	☐	☐	☐	☐
Very Well	Above Average	Average	Below Average	Poor

3. What do you think are the most important reasons for studying mathematics?

4. When you start work on a word problem, what do you do first?

5. When you finish working on a word problem, what is the last thing you do?

PART B - ACHIEVEMENT SURVEY
GRADE 7

CIRCLE THE CORRECT RESPONSE IN QUESTIONS 1 TO 3.

1. By rounding off to the nearest ten, an estimate of 91 x 29 would be ...

A. 270
B. 279
C. 2 700
D. 27 000
E. I don't know.

2. If John had 2300 marbles, how many bags of 10 marbles each could he make?

A. 23
B. 230
C. 2 300
D. 23 000
E. I don't know.

3. Sue has 58¢. If apples cost 11¢ each, what is the greatest number of whole apples that Sue can buy?

A. 4
B. 5
C. 6
D. 47
E. I don't know.

SHOW ALL YOUR WORK FOR EACH OF THE FOLLOWING QUESTIONS IN THIS BOOKLET.

4. Add:

$$\begin{array}{r} 0.68 \\ 0.21 \\ +\ \underline{0.34} \end{array}$$

5. Multiply:

$$5 \times 7 \times 6$$

6. Evaluate:

$$2 \times 7 + 2 \times 9$$

7. Subtract:

$$\begin{array}{r} 94.61 \\ -\ \underline{26.85} \end{array}$$

8. Divide:

$$12.2\ \overline{)\,671}$$

9. Multiply:

$$9.3 \times 16$$

10. Evaluate:

$$(\frac{2}{5} + \frac{1}{5}) \times 45$$

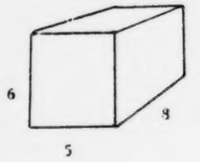
11. Mrs. Smith had $94.10. She bought some groceries for $24.85. How much money did she have left?

12. Betty, Mary and Sue want to buy their mother a present for Mother's Day. Betty has 58 cents; Mary has 75 cents; Sue has 89 cents. How much money do they have altogether?

13. What is the area of a rectangular piece of cloth that measures 8.5 centimetres by 15 centimetres?

14. A dump truck can hold 15.5 m^3 of gravel at one time. How many trips would be required to haul away 2480 m^3 of gravel?

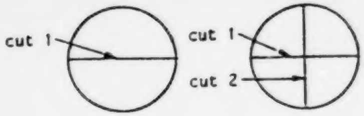
15. Find the volume of this box:



16. Mr. Jones put a fence around his rectangular garden. The garden is 10 m long and 6 m wide. How many metres of fencing did he use?

17. Mrs. Smith baked 48 cookies. Billy ate $\frac{1}{8}$ of the cookies and Betty ate $\frac{1}{8}$ of the cookies. In all, how many cookies were eaten?

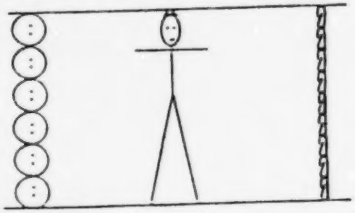
18. In the diagram shown below, a cake is cut so that all cuts are made through the center. Find how many pieces there will be after 10 cuts.



19. I am a number between 25 and 40. I have a remainder of two when divided by both 6 and 9. Who am I?

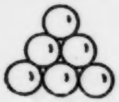
20. There are 6 fence posts on one side of a garden. The posts are 2 m apart. What is the distance from the first post to the last post?

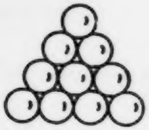
21. The stickman below is Mr. Big. He is 9 paper clips tall or 6 buttons tall. There is another stickman, Mr. Short, who is 6 paper clips tall. How many buttons tall would he be?



22. Some candies cost 10 cents each and others cost 25 cents each. Susan bought 3 candies. How many different amounts could Susan have spent?

23. Marbles are arranged in the shape of a triangle on the floor. How many marbles are there in a triangle with 7 marbles in the base?



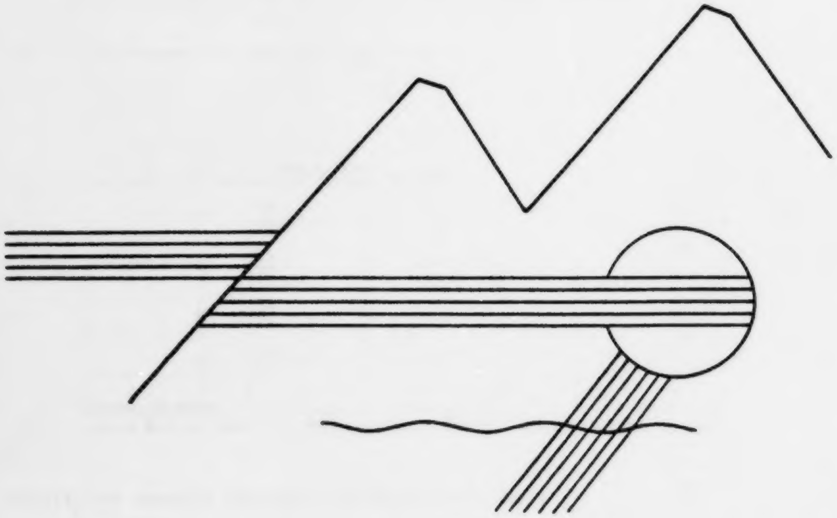


BRITISH COLUMBIA

MATHEMATICS ASSESSMENT 1985

GRADE 10

Q-1



PART A - BACKGROUND QUESTIONS
GRADE 10

1. Are you a boy or a girl? Check the box that applies.

   GIRL ☐ BOY ☐

2. What do you think are the most important reasons for studying mathematics?

3. Was the Mathematics 10 course you took earlier this year or are currently taking designed to prepare you to take Algebra 11?

4. Which mathematics course do you plan to take in Grade 11?

5. What do you plan to do after leaving secondary school?

PART B - ACHIEVEMENT SURVEY
GRADE 10

CIRCLE THE CORRECT RESPONSE IN QUESTIONS 1 TO 3.

1. There are 13 boys and 15 girls in a group. What fraction of the group is boys?

   A. $\frac{15}{28}$

   B. $\frac{13}{15}$

   C. $\frac{15}{13}$

   D. $\frac{13}{28}$

   E. I don't know.

2. The closest estimate for $\sqrt{640}$ would be

   A. 20

   B. 30

   C. 25

   D. 80

   E. I don't know.

3. A used automobile can be bought for cash for $2850, or on credit with a downpayment of $400 and $80 a month for three years. How much __more__ would a person pay by buying on credit than by buying the car for cash?

   A. $3280

   B. $ 640

   C. $ 430

   D. $ 400

   E. I don't know.

SHOW ALL OF YOUR WORK FOR EACH OF THE FOLLOWING QUESTIONS IN THIS BOOKLET.

4. Which one is the smallest of these? ________

   n + 1   n + 4   n - 3   n   n - 7

   Which one is the largest? ________

5. Which one is larger: 2n or n + 2? ________

   Explain your answer.

6. __4 added to n__ can be written as __n + 4__.

   Add 4 onto each of these:

   8   n + 5   3n

   ________   ________   ________

7. __n multiplied by 4__ can be written as __4n__.

   Multiply each of these by 4.

   8   n + 5   3n

   ________   ________   ________

8. If a + b = 43, then a + b + 2 = ________

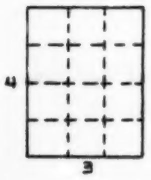
If n - 246 = 762, then n - 247 = ________

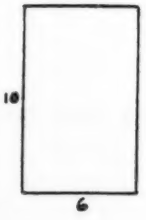
If e + f = 8, then e + f + g = ________

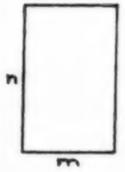
9. What can you say about a if a + 5 = 8?

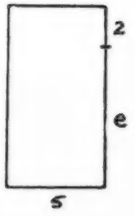
What can you say about b if b + 2 is equal to 2b?

10. What are the areas of these shapes?



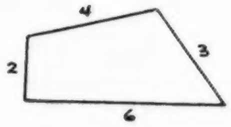




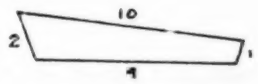


A = ______ A = ______ A = ______ A = ______

11. The perimeter of this shape is equal to 6 + 3 + 4 + 2, which equals 15.

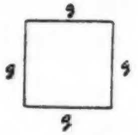


Determine the perimeter of this shape.

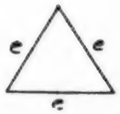


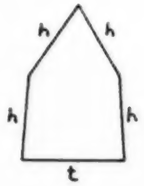
Perimeter = ________

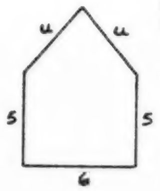
12. This square has sides of length g. So for its perimeter, we can write p = 4g



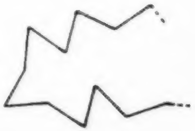
What can we write for the perimeter of each of these shapes?







Part of this figure is not drawn. There are n sides altogether, all of length 2.



P = ______ P = ______ P = ______ P = ______

13. What can you say about u if $u = v + 3$ and $v = 1$?

What can you say about m if $m = 3n + 1$ and $n = 4$?

14. If David has D records and Wendy has T records, what could you write for the number of records they have altogether?

15. $a + 3a$ can be written more simply as $4a$.

Write each of these more simply, where possible.

$2a + 5$ = ____________ $3a - (b + a)$ = ____________

$2a + 5b$ = ____________ $a + 4 + a - 4$ = ____________

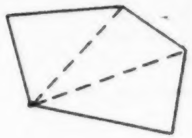
$(a + b) + a$ = ____________ $3a - b + a$ = ____________

$2a + 5b + a$ = ____________ $(a - b) + b$ = ____________

$(a + b) + (a - b)$ = ____________________________

16. What can you say about r if $r = s + t$ and $r + s + t = 30$?

17. In a shape like this you can work out the number of diagonals by taking away 3 from the number of sides.



So, a shape with 5 sides has 2 diagonals;

a shape with 57 sides has ____________ diagonals;

a shape with k sides has ____________ diagonals.

18. What can you say about c if $c + d = 10$ and c is less than d?

19. Tom's basic wage is \$200 per week.
He is also paid another \$10 for each hour of overtime that he works.

If h stands for the number of hours of overtime that he works, and if W stands for his _total_ weekly wage (in dollars), write down an equation connecting W and h.

What would Tom's total wage be if he worked 4 hours of overtime?

20. When are the following true--always, never, or sometimes. (Underline the correct answer.)

$A + B + C = C + A + B$

Always Never Sometimes, when ______________

$L + M + N = L + P + N$

Always Never Sometimes, when ______________

21. $a = b + 3$. What happens to a if b is increased by 2?

$f = 3g + 1$. What happens to f if g is increased by 2?

22. Muffins cost m cents each and buns cost b cents each. If I buy 4 muffins and 3 buns, what does $4m + 3b$ stand for?

23. If the equation $(x + 1)^3 + x = 349$ is true when $x = 6$, then what value of x will make the following equation true?

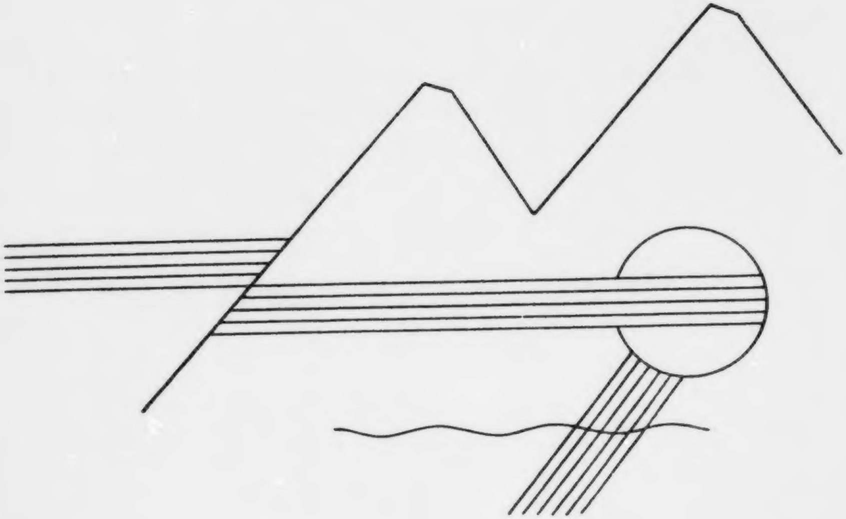
$$(5x + 1)^3 + 5x = 349$$

24. Blue pencils cost 5 cents each and red pencils cost 6 cents each. I buy some blue and some red pencils and altogether it costs me 90 cents.

If b is the number of blue pencils bought, and if r is the number of red pencils bought, what can you write down about b and r?

BRITISH COLUMBIA
MATHEMATICS ASSESSMENT 1985

GRADE 10
Q-2



PART A - BACKGROUND QUESTIONS
GRADE 10

1. Are you a boy or a girl? Check the box that applies.

   GIRL ☐ BOY ☐

2. Which one of the following best describes how well you feel you do in mathematics? Check the box that applies.

   ☐ Very Well ☐ Above Average ☐ Average ☐ Below Average ☐ Poor

3. What do you think are the most important reasons for studying mathematics?

4. When you start work on a word problem, what do you do first?

5. When you finish working on a word problem, what is the last thing you do?

6. Was the Mathematics 10 course you either took earlier this year or are currently taking designed to prepare you to take Algebra 11?

7. Which mathematics course do you plan to take in Grade 11?

8. What do you plan to do after leaving secondary school?

1. There are 13 boys and 15 girls in a group. What fraction of the group is boys?

   A. $\frac{15}{28}$

   B. $\frac{13}{15}$

   C. $\frac{15}{13}$

   D. $\frac{13}{28}$

   E. I don't know.

2. The closest estimate for $\sqrt{640}$ would be

   A. 20
   B. 30
   C. 25
   D. 80
   E. I don't know.

3. A used automobile can be bought for cash for $2850, or on credit with a downpayment of $400 and $80 a month for three years. How much more would a person pay by buying on credit than by buying the car for cash?

   A. $3280
   B. $ 640
   C. $ 430
   D. $ 400
   E. I don't know.

SHOW ALL OF YOUR WORK FOR EACH OF THE FOLLOWING QUESTIONS IN THIS BOOKLET.

4. **Divide:**

$$12.2\,\overline{)\,671}$$

5. Evaluate:

$$2 \times 7 + 2 \times 9$$

6. 35 is what percent of 175?

7. Divide:

$$26 \div 3\tfrac{1}{4}$$

8. Multiply:

$$15 \times 5 \times 3.2$$

9. Add:

$$3\tfrac{1}{2} + 7\tfrac{1}{4} + 9\tfrac{1}{3}$$

10. Solve for x:

$$3x - 2 = 16$$

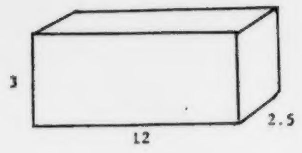
11. A dump truck can hold 15.5 m^3 of gravel at one time. How many trips would be required to haul away 2480 m^3 of gravel?

12. Mr. Jones put a fence around his rectangular garden. The garden is 10 m long and 6 m wide. How many metres of fencing did he use?

13. In a school election with three candidates, Mike received 120 votes, Lawrence received 30 votes, and Lesley received 50 votes. What percent of the total vote did Mike receive?

14. A carpenter cuts a board 10 metres long into lengths of $2\frac{1}{2}$ metres. How many lengths will he get?

15. Find the volume of this box



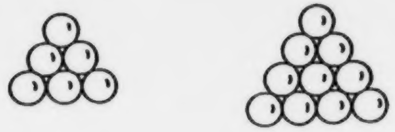
16. Bill's mother bought $2\frac{1}{3}$ dozen chocolate chip cookies, $1\frac{1}{4}$ dozen ginger snaps, and $1\frac{1}{2}$ dozen peanut butter cookies. How many dozen cookies did she buy altogether?

17. Carol owns 3 less than twice as many records as Bob. If she owns 17 records, how many does Bob own?

18. A litre of asphalt paint will cover about 6 m^2 of surface. The paint is sold in cans of 5 litres only. How many cans are needed to paint a driveway 15 m long and 3 m wide?

19. Some candies cost 10 cents each and others cost 25 cents each. Susan bought 3 candies. How many different amounts could Susan have spent?

20. Marbles are arranged in the shape of a triangle on the floor. How many marbles are there in a triangle with 7 marbles in the base?



21. I am a number between 25 and 40. I have a remainder of two when divided by both 6 and 9. Who am I?

22. Susan and Bill went fishing. They both caught two kinds of fish, herring and cod. Bill caught 10 herring. Together they caught 18 herring and 10 cod. Susan caught 15 fish. How many cod did Bill catch?

23. There are 6 fence posts on one side of a garden. The posts are 2 m apart. What is the distance from the first post to the last post?

1. There are 13 boys and 15 girls in a group. What fraction of the group is boys?

   A. $\frac{15}{28}$

   B. $\frac{13}{15}$

   C. $\frac{15}{13}$

   D. $\frac{13}{28}$

   E. I don't know.

2. The closest estimate for $\sqrt{640}$ would be

   A. 20

   B. 30

   C. 25

   D. 80

   E. I don't know.

3. A used automobile can be bought for cash for $2850, or on credit with a downpayment of $400 and $80 a month for three years. How much more would a person pay by buying on credit than by buying the car for cash?

   A. $3280

   B. $ 640

   C. $ 430

   D. $ 400

   E. I don't know.

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4. **Divide:**

$$12.2\overline{)671}$$

5. Evaluate:

$$2 \times 7 + 2 \times 9$$

6. 35 is what percent of 175?

7. Divide:

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8. Multiply:

$$15 \times 5 \times 3.2$$

9. Add:

$$3\frac{1}{2} + 7\frac{1}{4} + 9\frac{1}{3}$$

10. Solve for x:

$$3x - 2 = 15$$

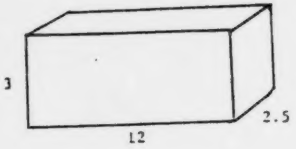
11. A dump truck can hold 15.5 m^3 of gravel at one time. How many trips would be required to haul away 2480 m^3 of gravel?

12. Mr. Jones put a fence around his rectangular garden. The garden is 10 m long and 6 m wide. How many metres of fencing did he use?

13. In a school election with three candidates, Mike received 120 votes, Lawrence received 30 votes, and Lesley received 50 votes. What percent of the total vote did Mike receive?

14. A carpenter cuts a board 10 metres long into lengths of $2\frac{1}{2}$ metres. How many lengths will he get?

15. Find the volume of this box



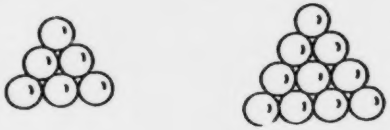
16. Bill's mother bought $2\frac{1}{3}$ dozen chocolate chip cookies, $1\frac{1}{4}$ dozen ginger snaps, and $1\frac{1}{2}$ dozen peanut butter cookies. How many dozen cookies did she buy altogether?

17. Carol owns 3 less than twice as many records as Bob. If she owns 17 records, how many does Bob own?

18. A litre of asphalt paint will cover about 6 m^2 of surface. The paint is sold in cans of 5 litres only. How many cans are needed to paint a driveway 15 m long and 3 m wide?

19. Some candies cost 10 cents each and others cost 25 cents each. Susan bought 3 candies. How many different amounts could Susan have spent?

20. Marbles are arranged in the shape of a triangle on the floor. How many marbles are there in a triangle with 7 marbles in the base?



21. I am a number between 25 and 40. I have a remainder of two when divided by both 6 and 9. Who am I?

22. Susan and Bill went fishing. They both caught two kinds of fish, herring and cod. Bill caught 10 herring. Together they caught 18 herring and 10 cod. Susan caught 15 fish. How many cod did Bill catch?

23. There are 6 fence posts on one side of a garden. The posts are 2 m apart. What is the distance from the first post to the last post?